

AD-A126 005

ANALYTICAL AND EXPERIMENTAL STUDY TO IMPROVE COMPUTER
MODELS FOR MIXING A. (U) SOUTHWEST RESEARCH INST SAN
ANTONIO TX F T DODGE ET AL. AUG 82 USCG-D-2-83

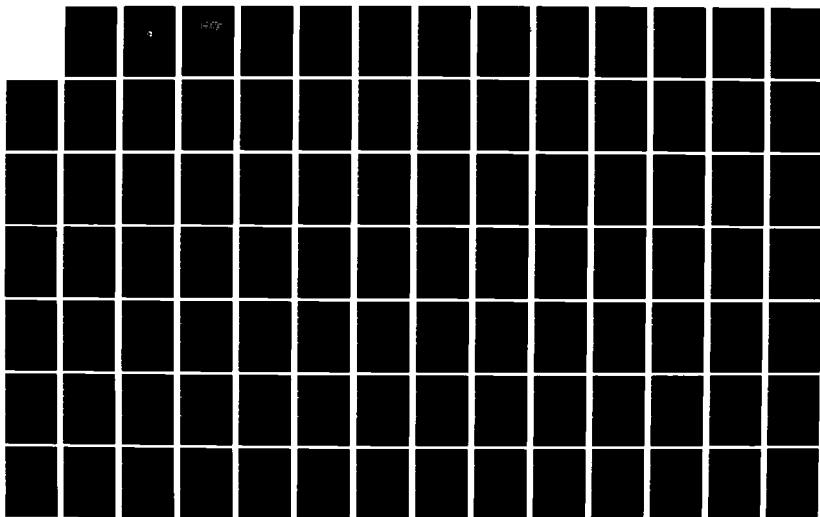
1/2

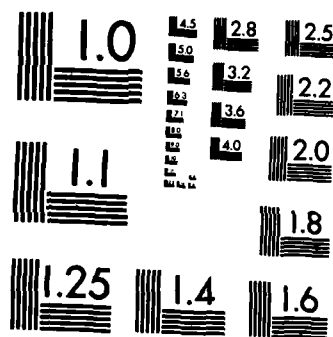
UNCLASSIFIED

DOT-CG-920622-A

F/G 7/1

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ANALYTICAL AND EXPERIMENTAL STUDY TO IMPROVE
COMPUTER MODELS FOR MIXING AND DILUTION OF
SOLUBLE HAZARDOUS CHEMICALS: TEST DATA VOLUME

FRANKLIN T. DODGE
J. CHRISTOPHER BUCKINGHAM
THOMAS B. MORROW



FINAL REPORT

AUGUST 1982

Document is available to the public through the
National Technical Information Service,
Springfield, Virginia 22161

Prepared for

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
Office of Research and Development
Washington, D.C. 20593

DTIC

1983

[Handwritten signature] E

83 33 22 039

ADA126005

DTIC FILE COPY

SOUTHWEST RESEARCH INSTITUTE
Post Office Drawer 28510, 6220 Culebra Road
San Antonio, Texas 78284

ANALYTICAL AND EXPERIMENTAL STUDY TO IMPROVE COMPUTER MODELS FOR MIXING AND DILUTION OF SOLUBLE HAZARDOUS CHEMICALS: TEST DATA VOLUME

by

Franklin T. Dodge
J. Christopher Buckingham
Thomas B. Morrow

FINAL REPORT
Contract DOT-CG-920622-A
SwRI Project 02-5864

Prepared for
Commandant (G-FCP-2/71)
U. S. Coast Guard
400 Seventh Street, S. W.
Washington, D. C. 20590

August 1982



Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution	
Availability Codes	
Dist	
A	

Approved:

Robert L. Bass, Director
Department of Mechanical Sciences

TABLE OF APPENDICES CONTENTS

	<u>Pages</u>
Appendix A - Concentration Profiles for Run II.1-1	A-1 - A-14
Appendix B - Concentration Profiles for Run II.1-2	B-1 - B-21
Appendix C - Concentration Profiles for Run II.1-7A	C-1 - C-14
Appendix D - Concentration Profiles for Run II.1-7B	D-1 - D-18
Appendix E - Concentration Profiles for Run II.1-8A	E-1 - E-6
Appendix F - Concentration Profiles for Run II.1-8B	F-1 - F-14
Appendix G - Concentration Profiles for Run II.1-13	G-1 - G-18
Appendix H - Concentration Profiles for Run II.1-14	H-1 - H-20
Appendix I - Concentration Profiles for Run II.1-19	I-1 - I-3
Appendix J - Concentration Profiles for Run II.1-20q	J-1 - J-4
Appendix K - Concentration Profiles for Run I.2-3 at X = 48 In., 120 In.	K-1 - K-4
Appendix L - Concentration Profiles for Run I.2-4 at X = 48 In., 120 In.	L-1 - L-4
Appendix M - Concentration Profiles for Run I.2-9 at X = 48 In. 120 In.	M-1 - M-4
Appendix N - Concentration Profiles for Run I.2-11 at X = 48 In., 120 In.	N-1 - N-4
Appendix O - Concentration Profiles for Run I.2-12 at X = 48 In., 120 In., 240 In., 288 In., 336 In., 432 In.	O-1 - O-7
Appendix P - Concentration Profiles for Run I.2-19 at X = 48 In., 120 In.	P-1 - P-4
Appendix Q - Concentration Profiles for Run I.2-20 at X = 48 In., 120 In., 240 In., 336 In., 432 In.	Q-1 - Q-5
Appendix R - Concentration Profiles for Run I.2-26 at X = 48 In., 120 In.	R-1 - R-4
Appendix S - Concentration Profiles for Run I.2-27 at X = 120 In., 240 In., 432 In.	S-1

APPENDIX A

CONCENTRATION PROFILES FOR RUN II.1-1

$$\rho_c/\rho = 0.79 \text{ (Ethyl Alcohol)}$$

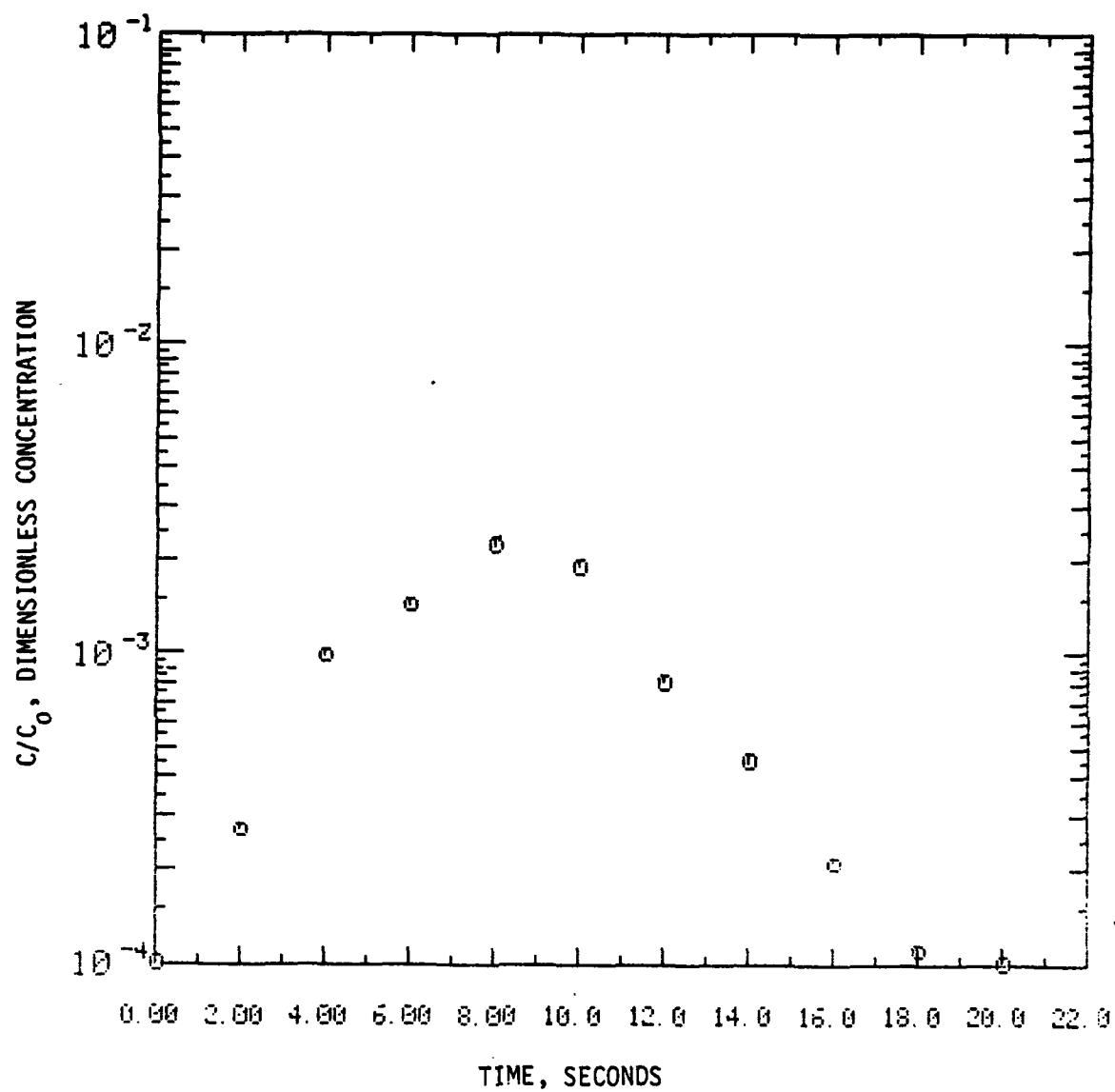
$$r_i/d = 0.125$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	28 sec.
cross stream profiles	28 sec.
vertical profiles	30 sec.



X = 168 IN., Y = 0, Z = 0.25 IN.

FIGURE A-1. RUN II.1-1 CONCENTRATION TIME HISTORY

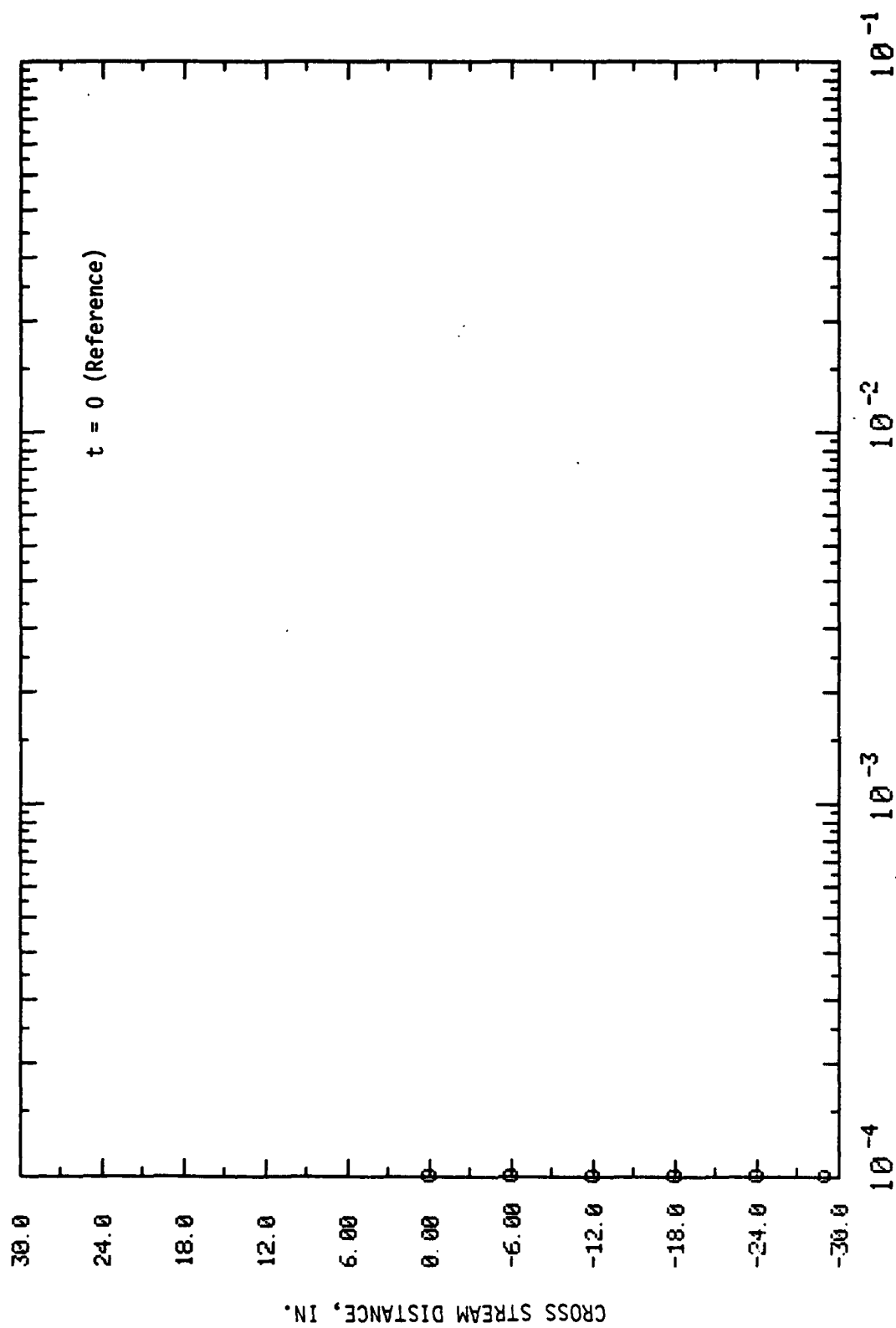


FIGURE A-2. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

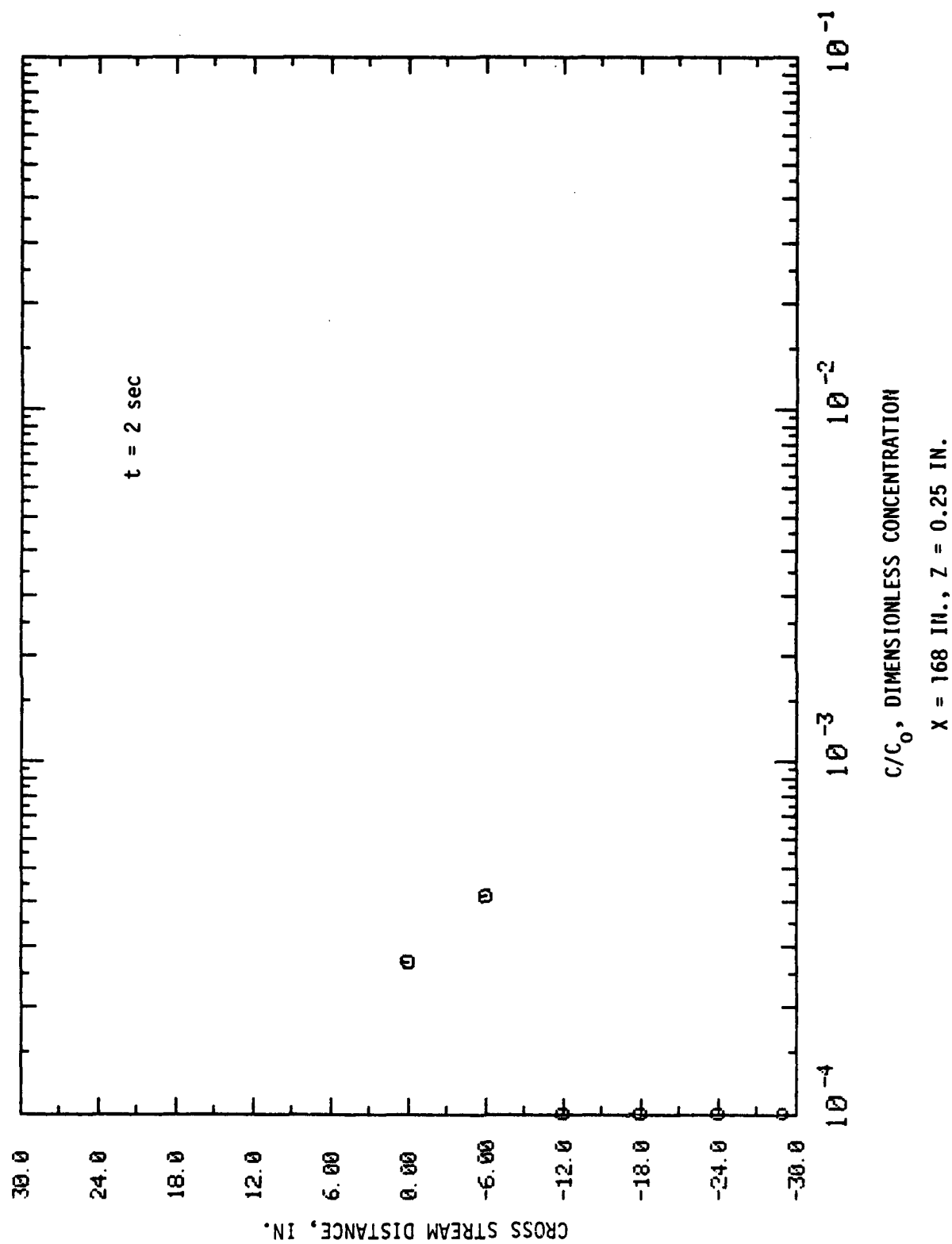


FIGURE A-3. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

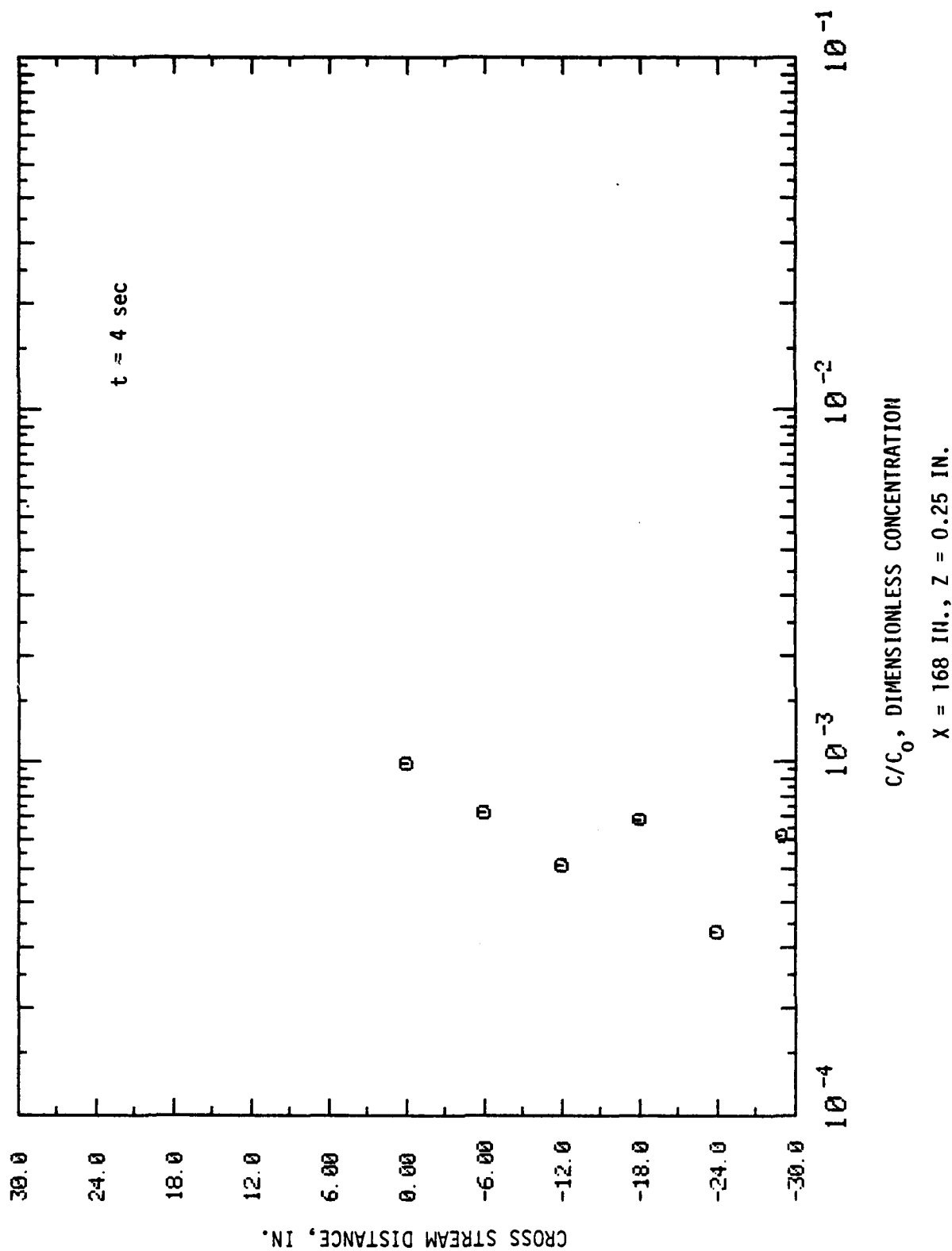
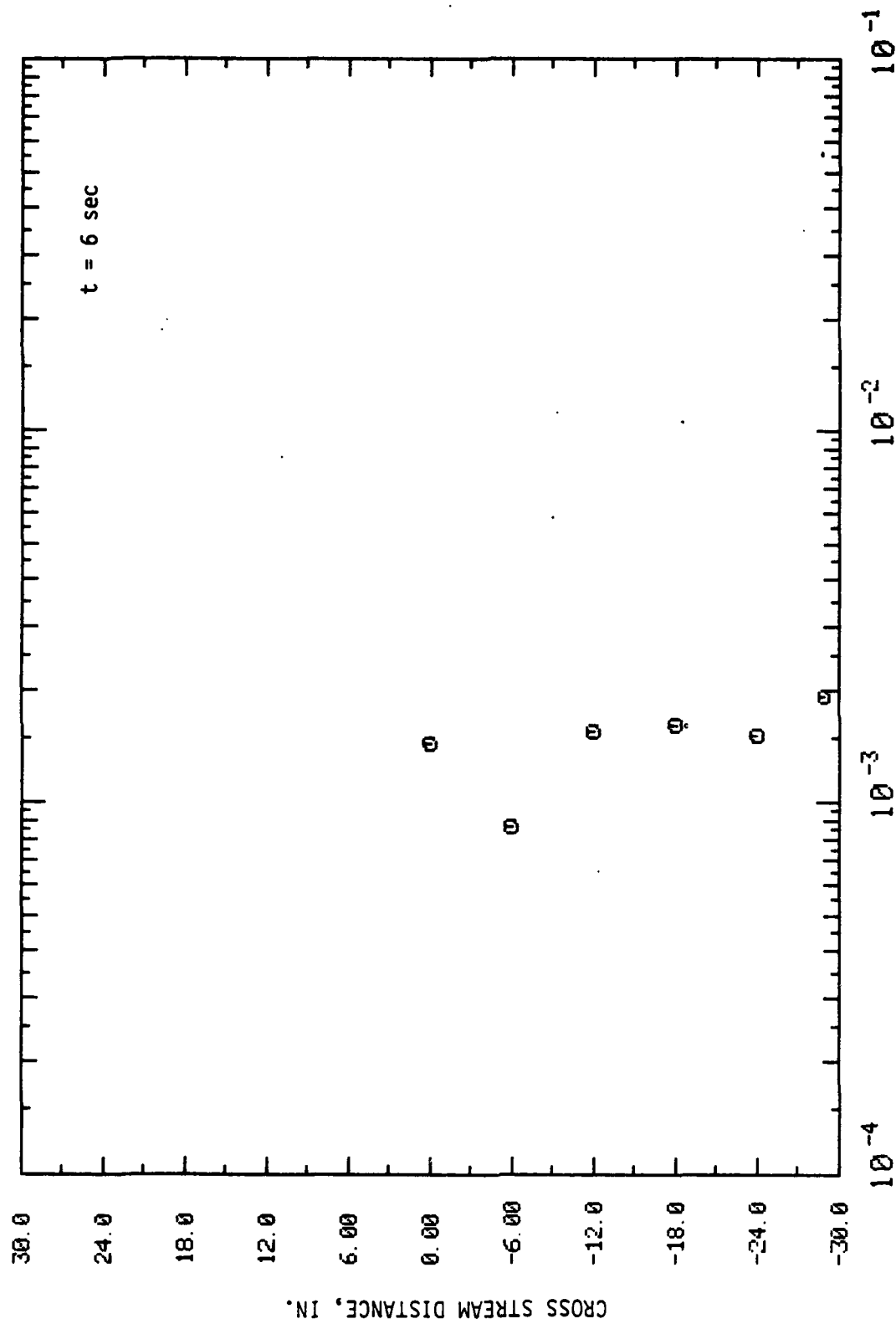


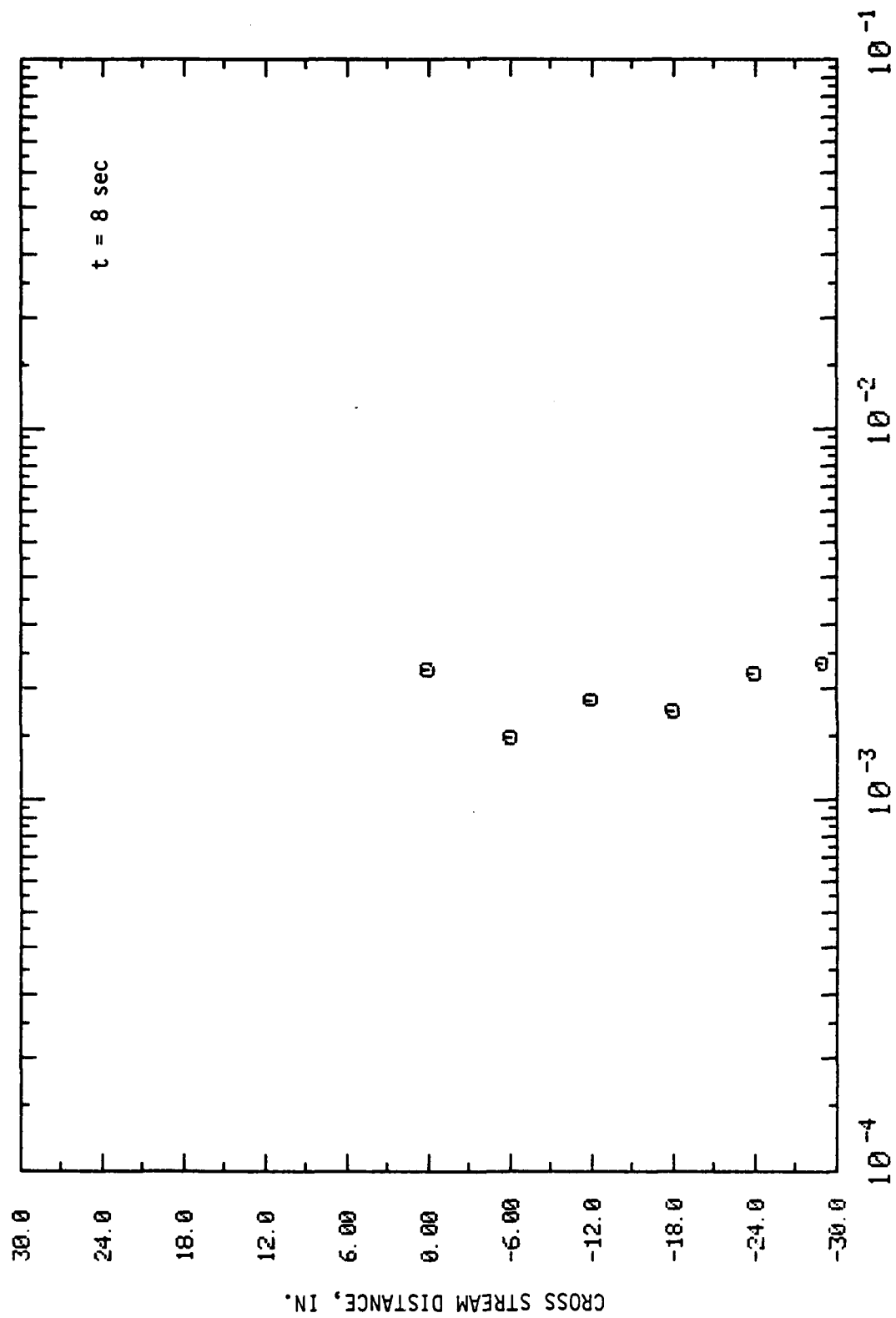
FIGURE A-4. RUN II.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

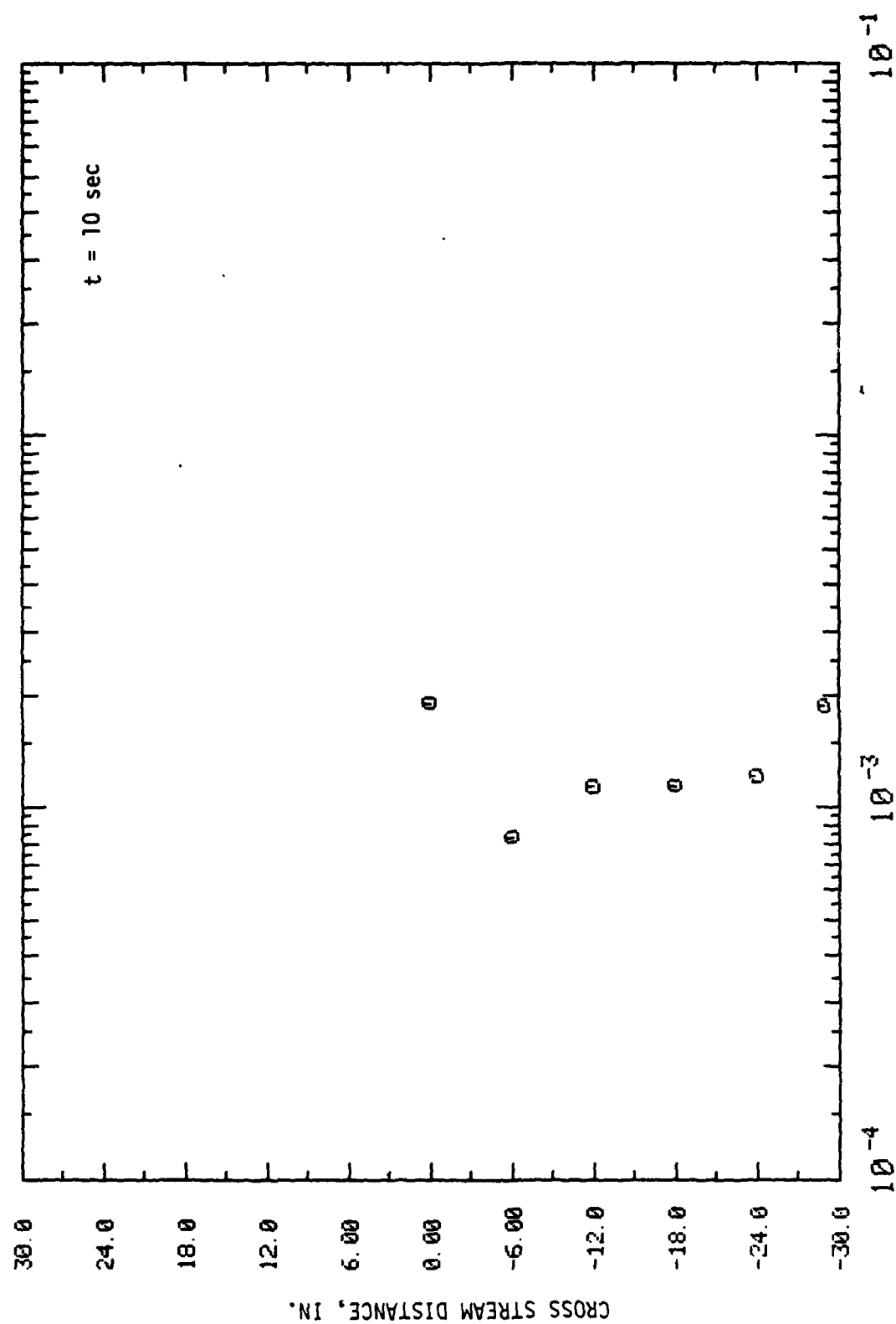
FIGURE A-5. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE A-6. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE A-7. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

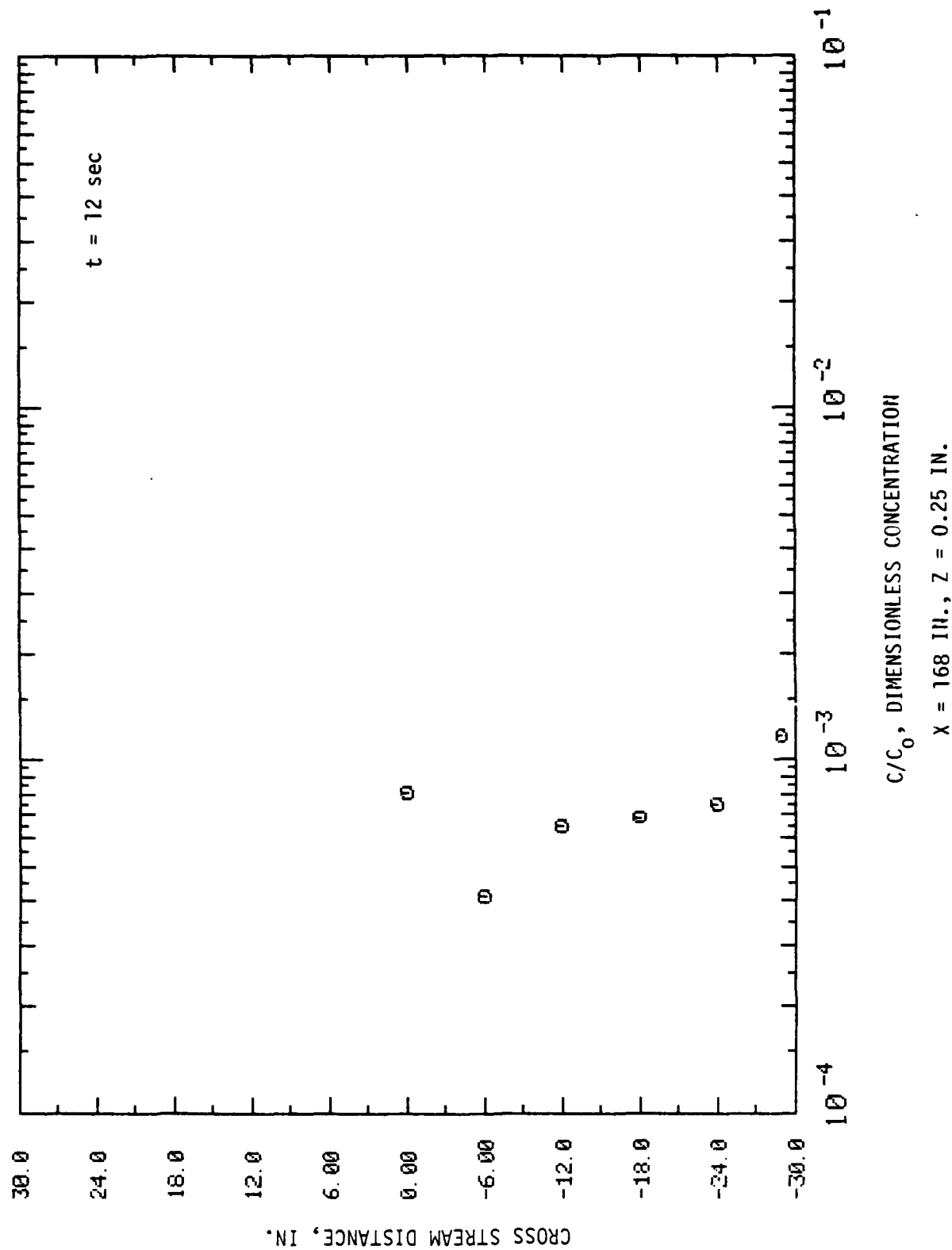
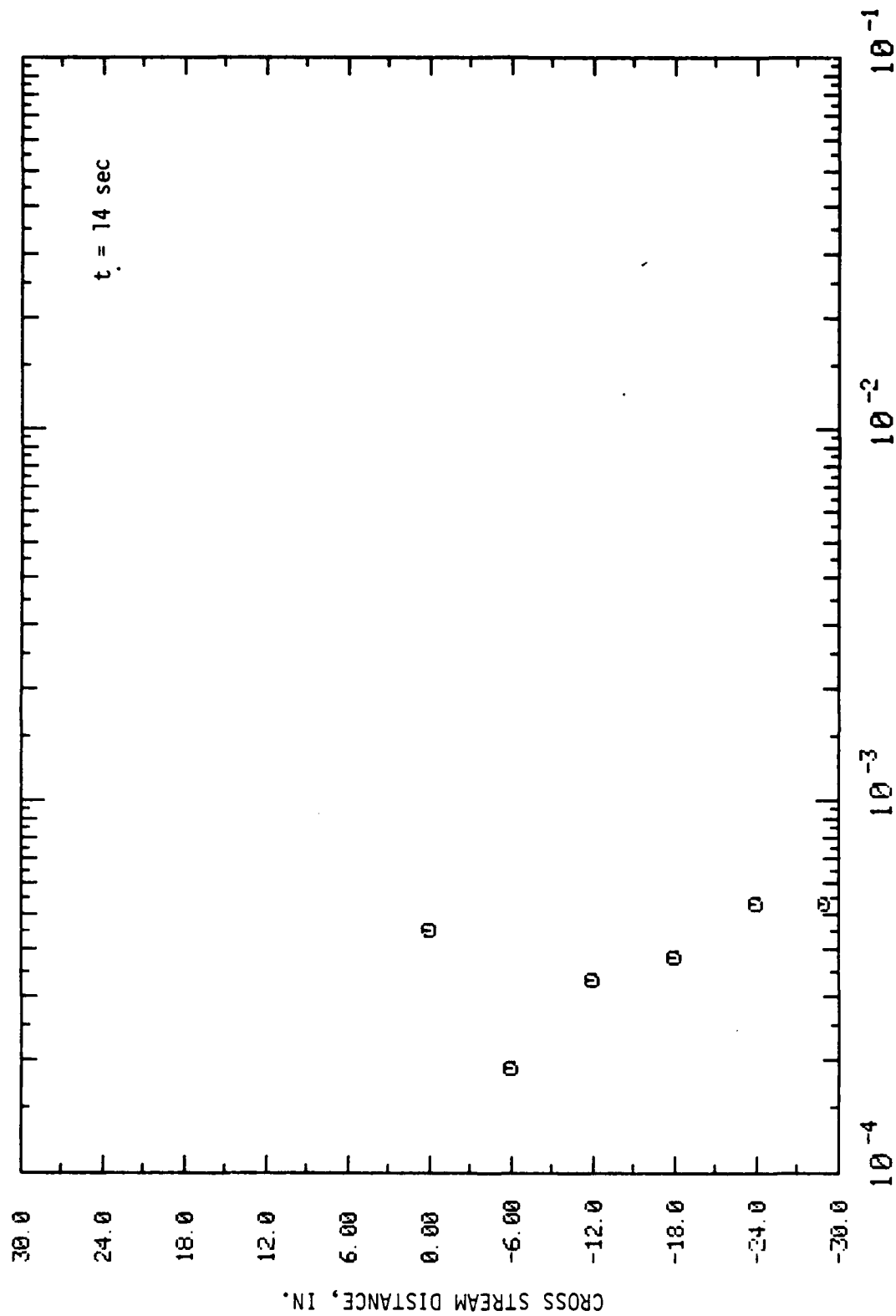


FIGURE A-8. RUN 11.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE A-9. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

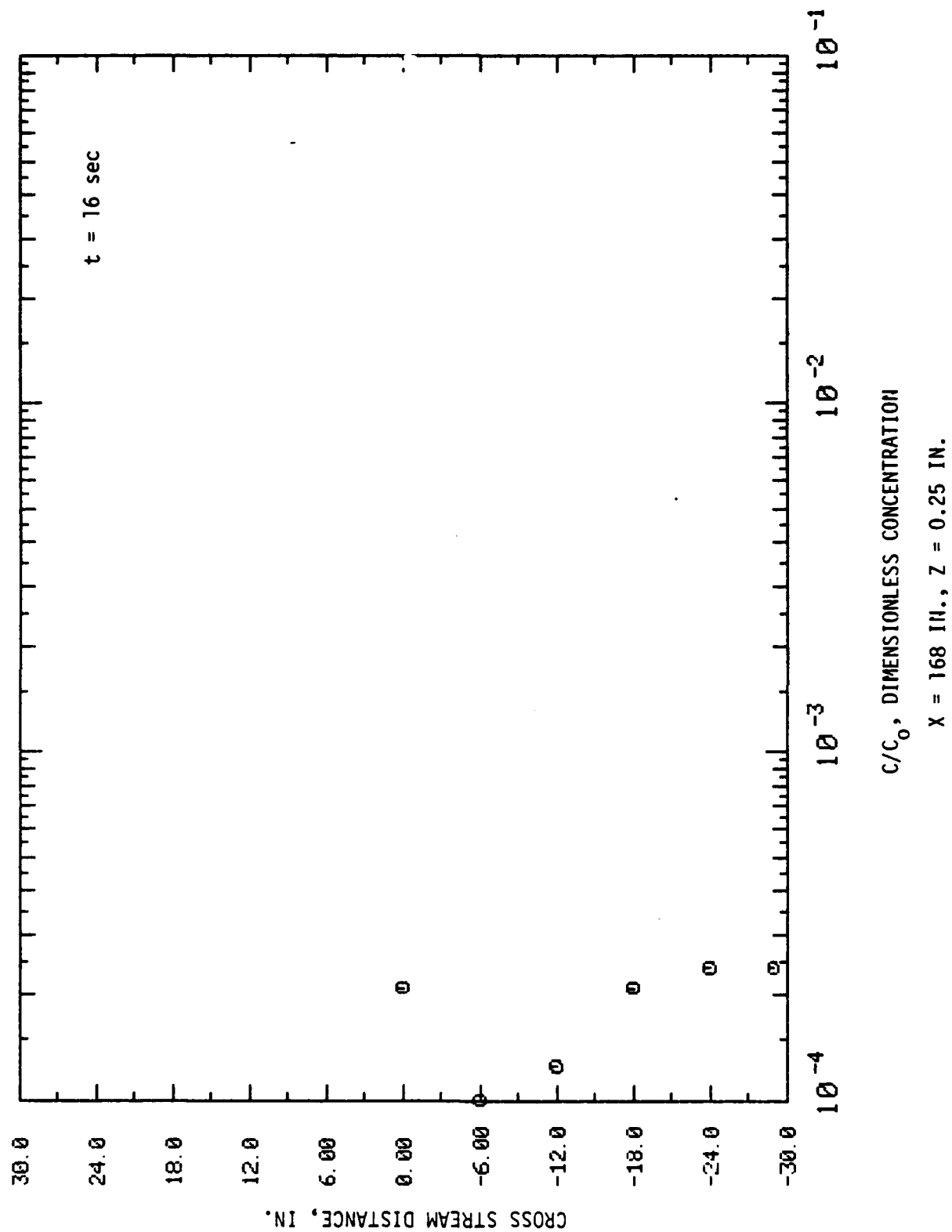


FIGURE A-10 . RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

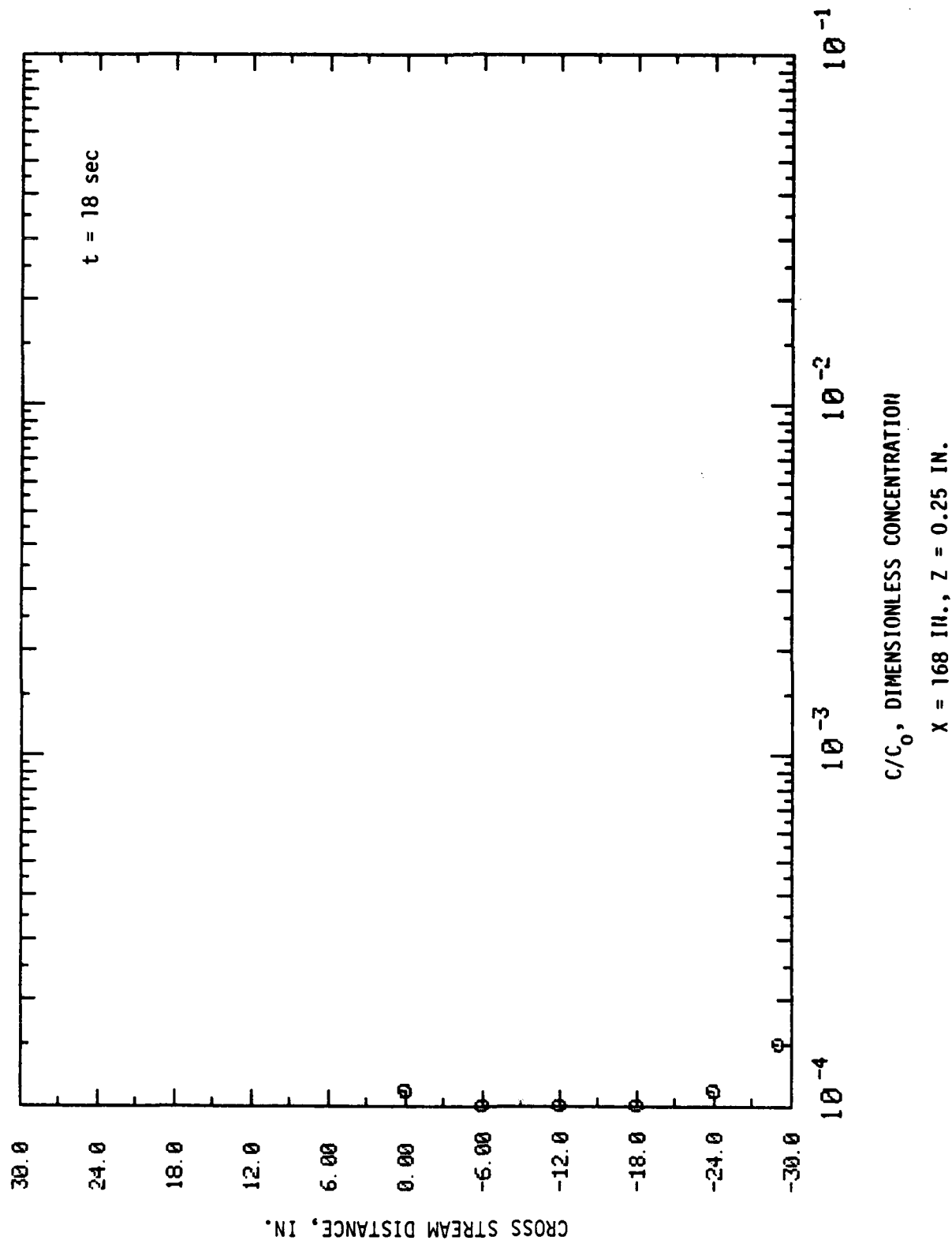
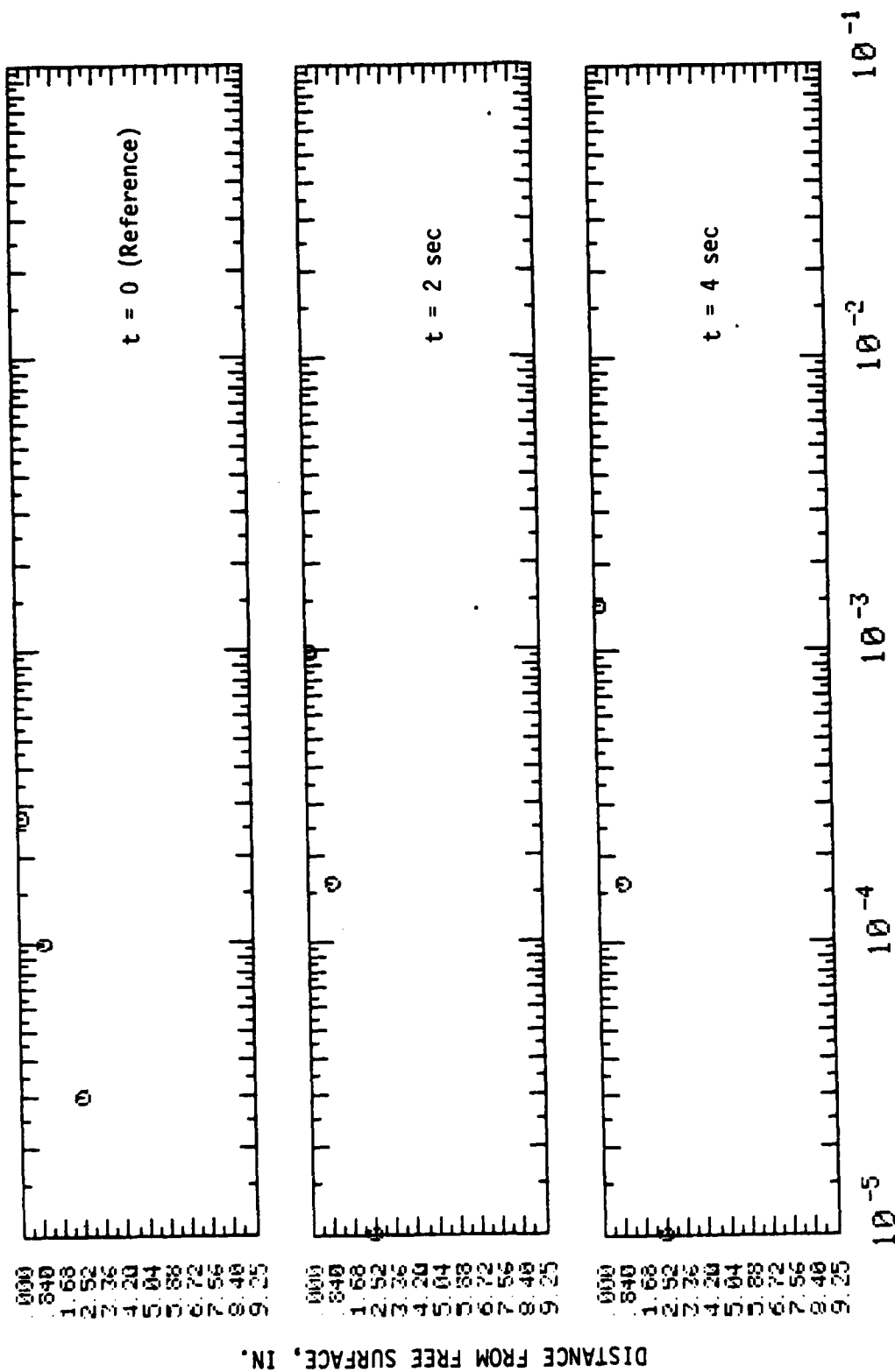


FIGURE A-11. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE A-12. RUN II.1-1 VERTICAL CONCENTRATION PROFILES

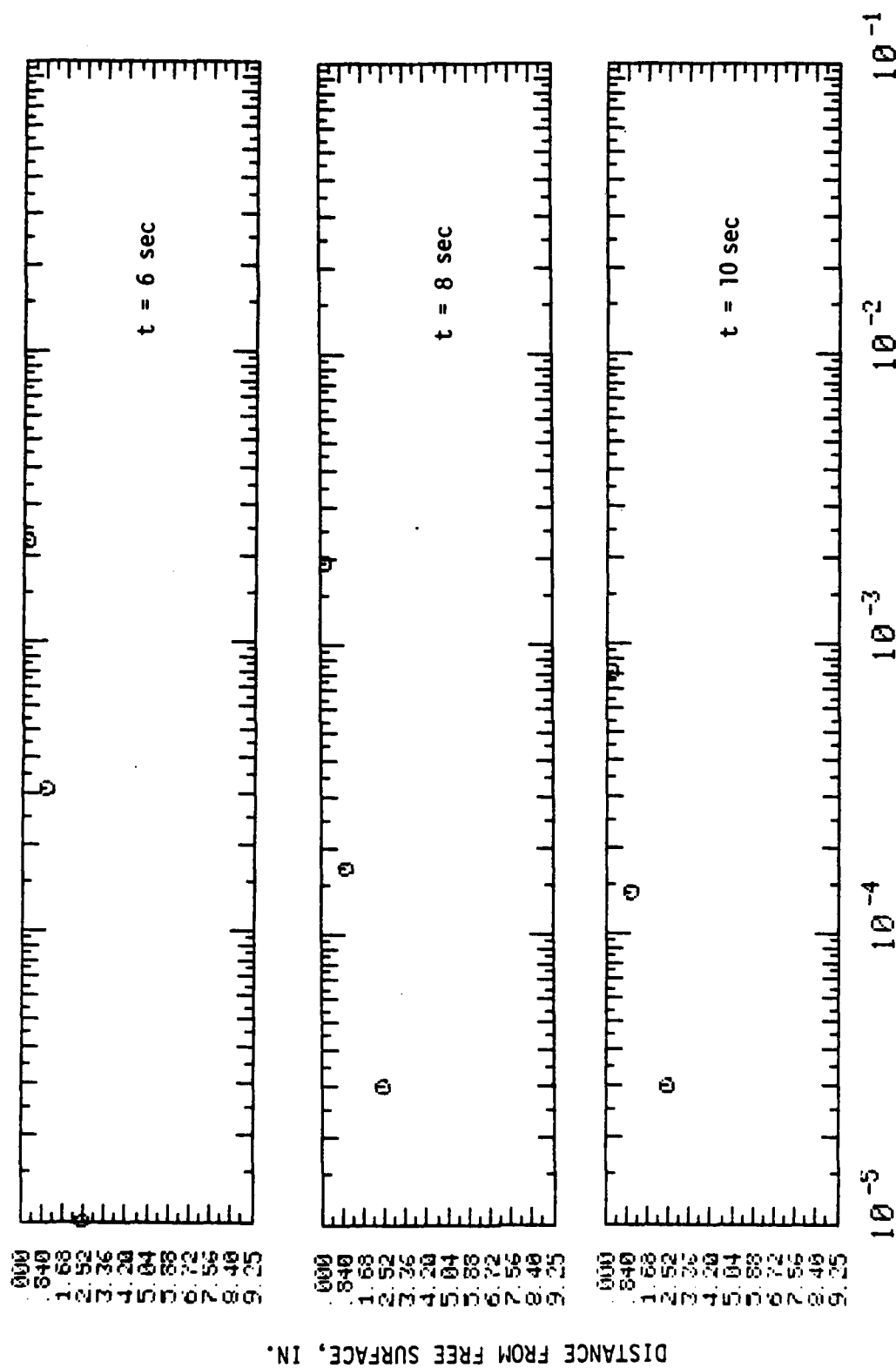
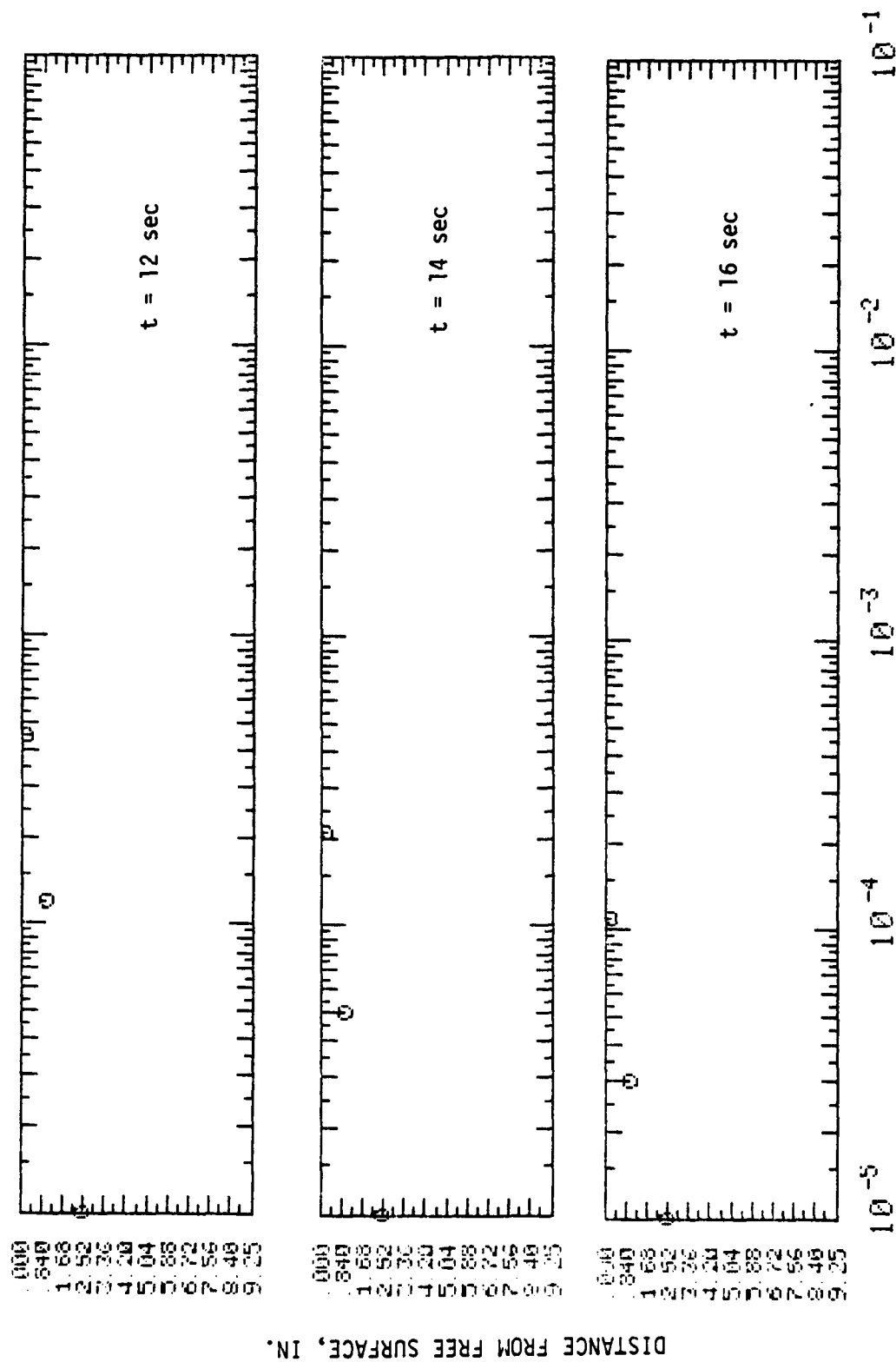


FIGURE A-13. RUN II.1-1 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE A-14. RUN II.1.1-1 VERTICAL CONCENTRATION PROFILES

APPENDIX B

CONCENTRATION PROFILES FOR RUN II.1-2

$$\rho_c/\rho = 0.79 \text{ (Ethyl Alcohol)}$$

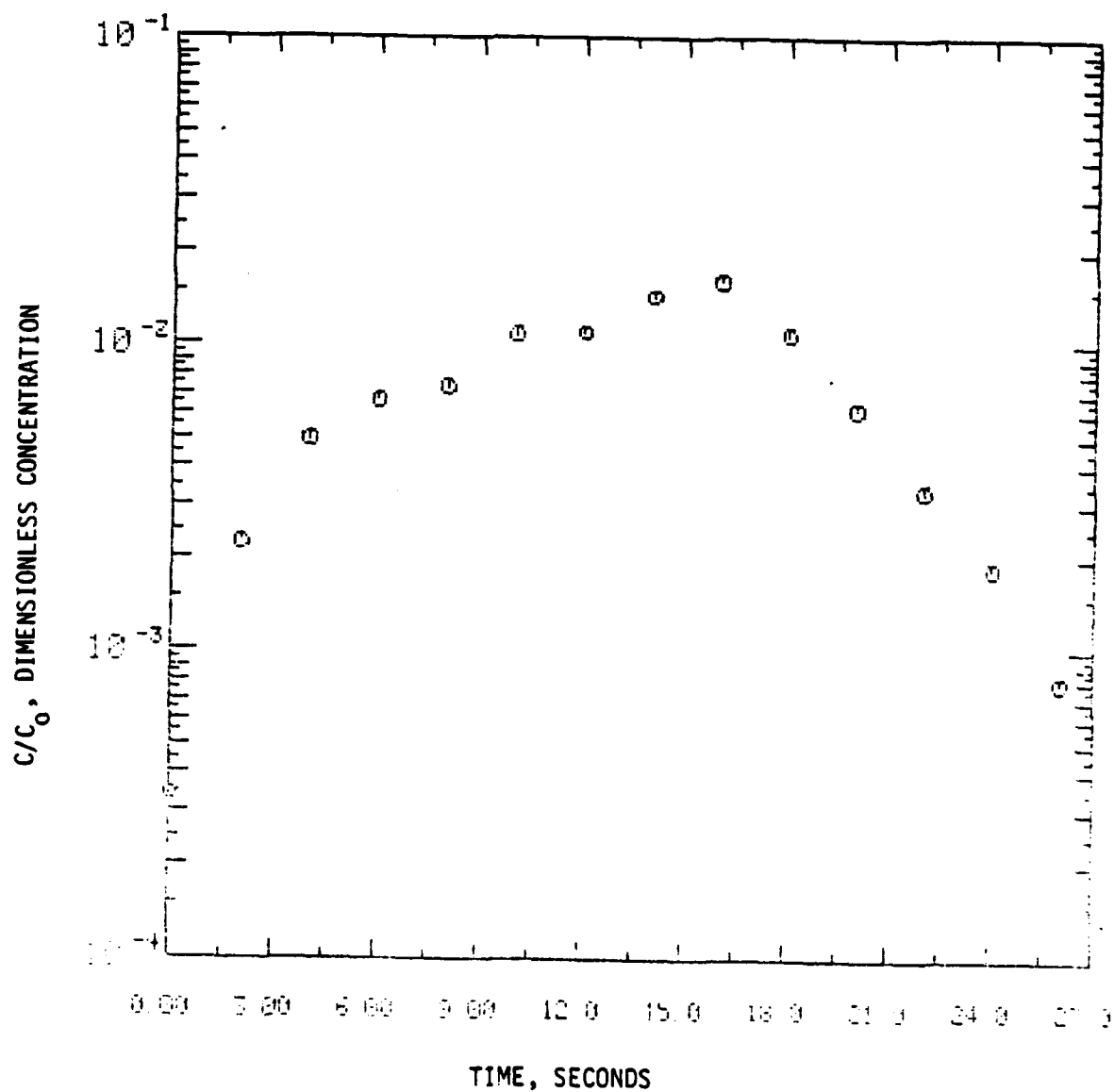
$$r_i/d = 0.23$$

$$u_r/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	27 sec.
cross stream profiles	27 sec.
vertical profiles	29 sec.



X = 168 IN., Y = 0, Z = 0.25 IN.

FIGURE B-1 . RUN II.1-2 CONCENTRATION TIME HISTORY

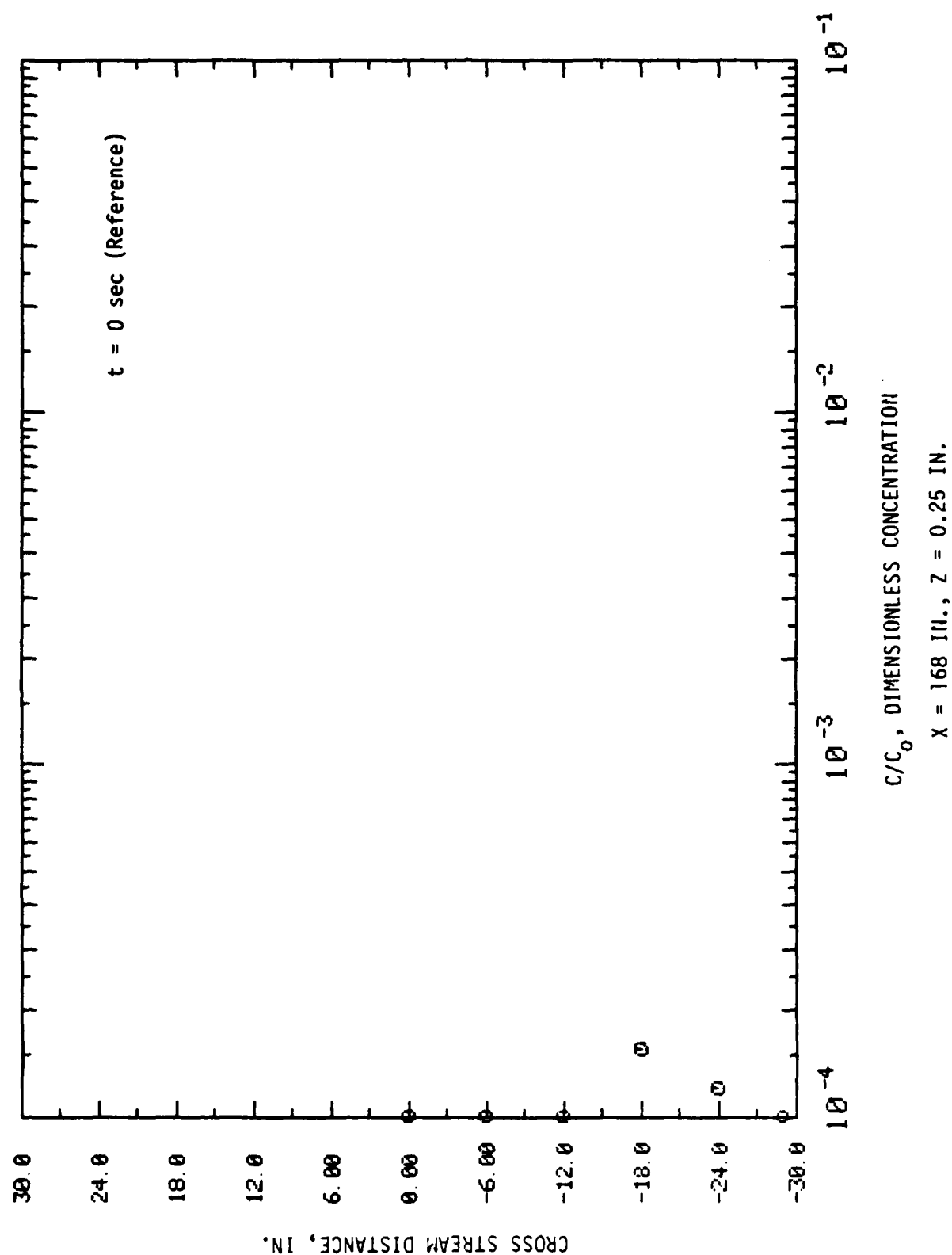


FIGURE B-2 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE

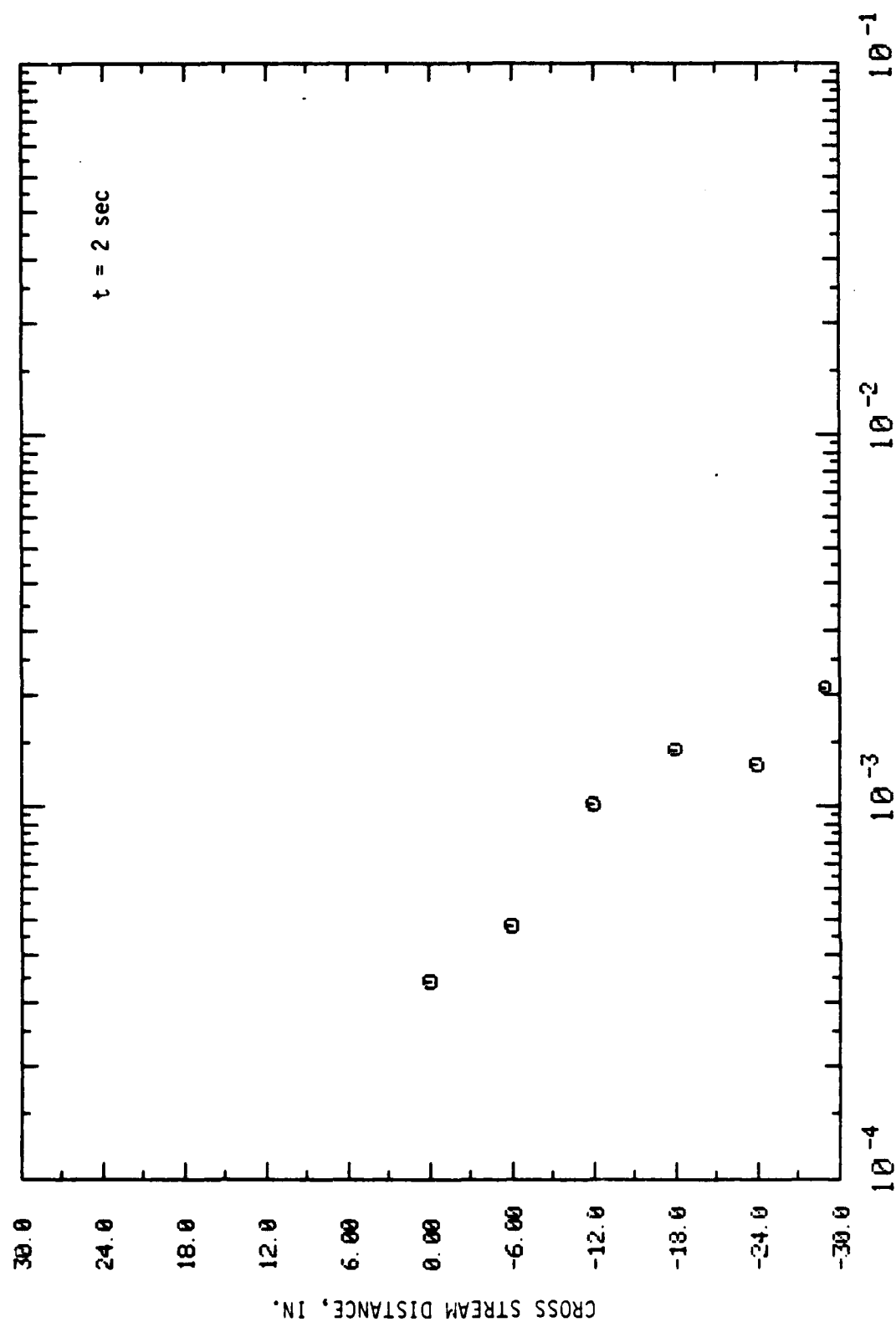


FIGURE B-3 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

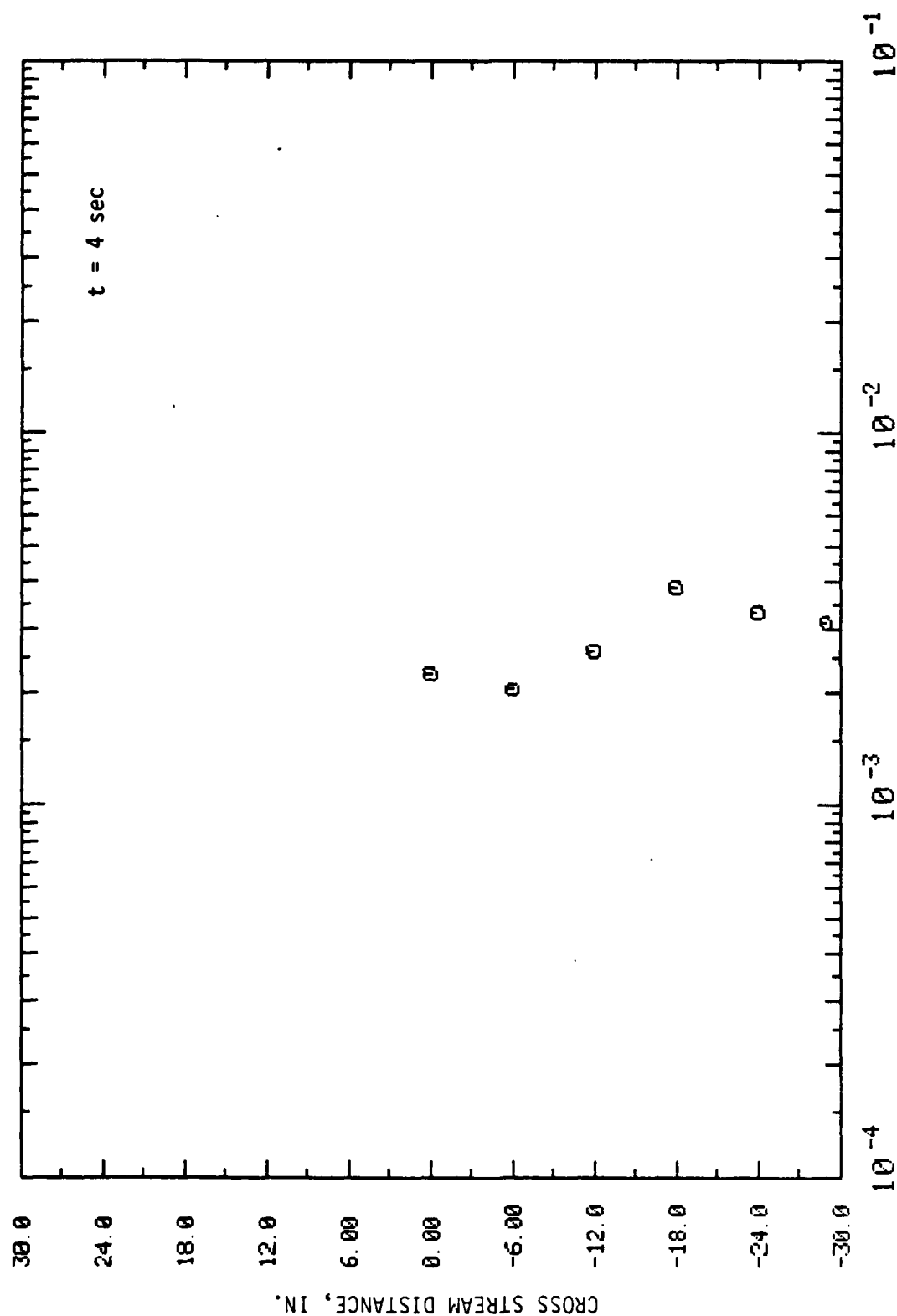
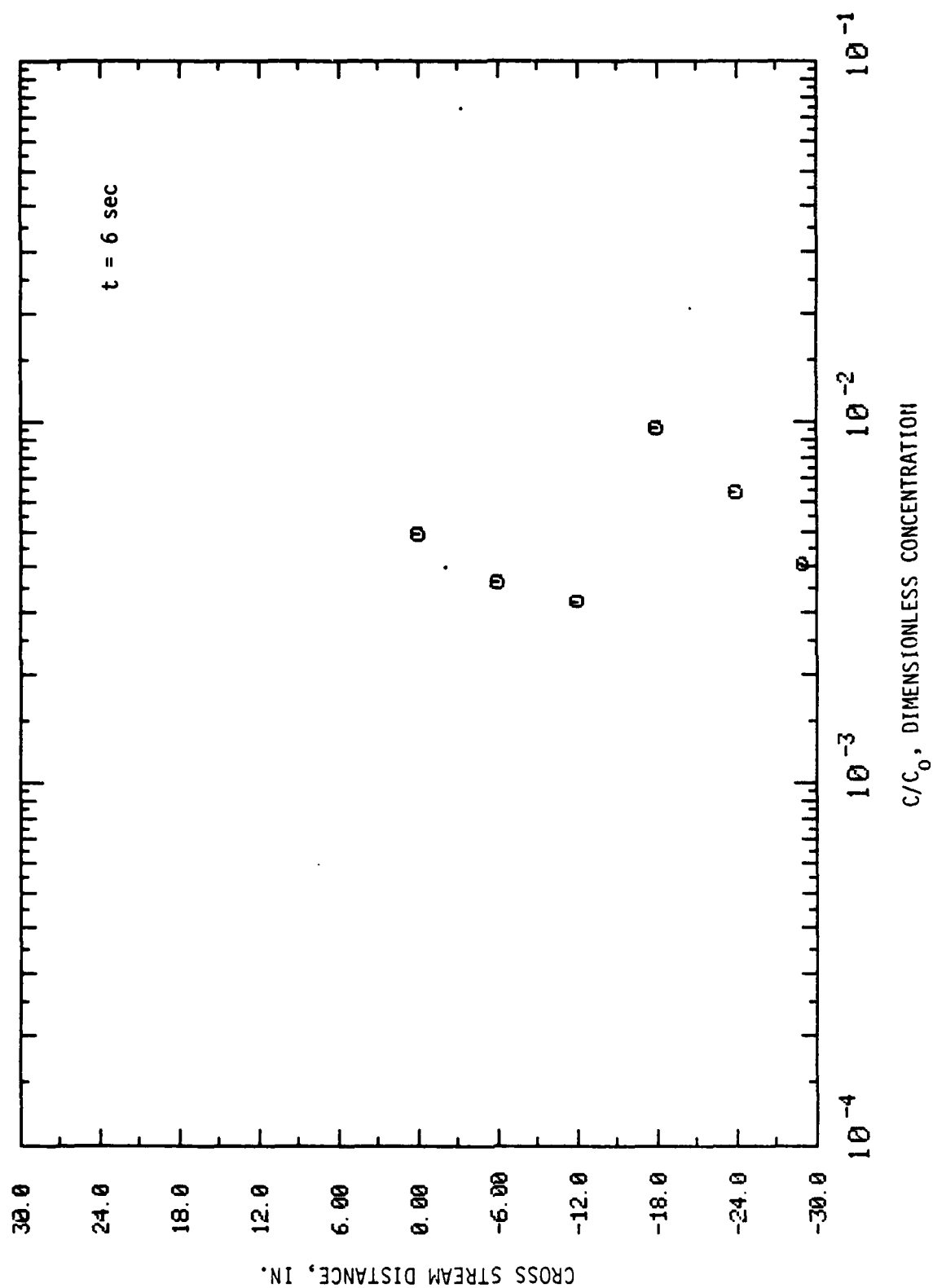


FIGURE B-4 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE



$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-5 . RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

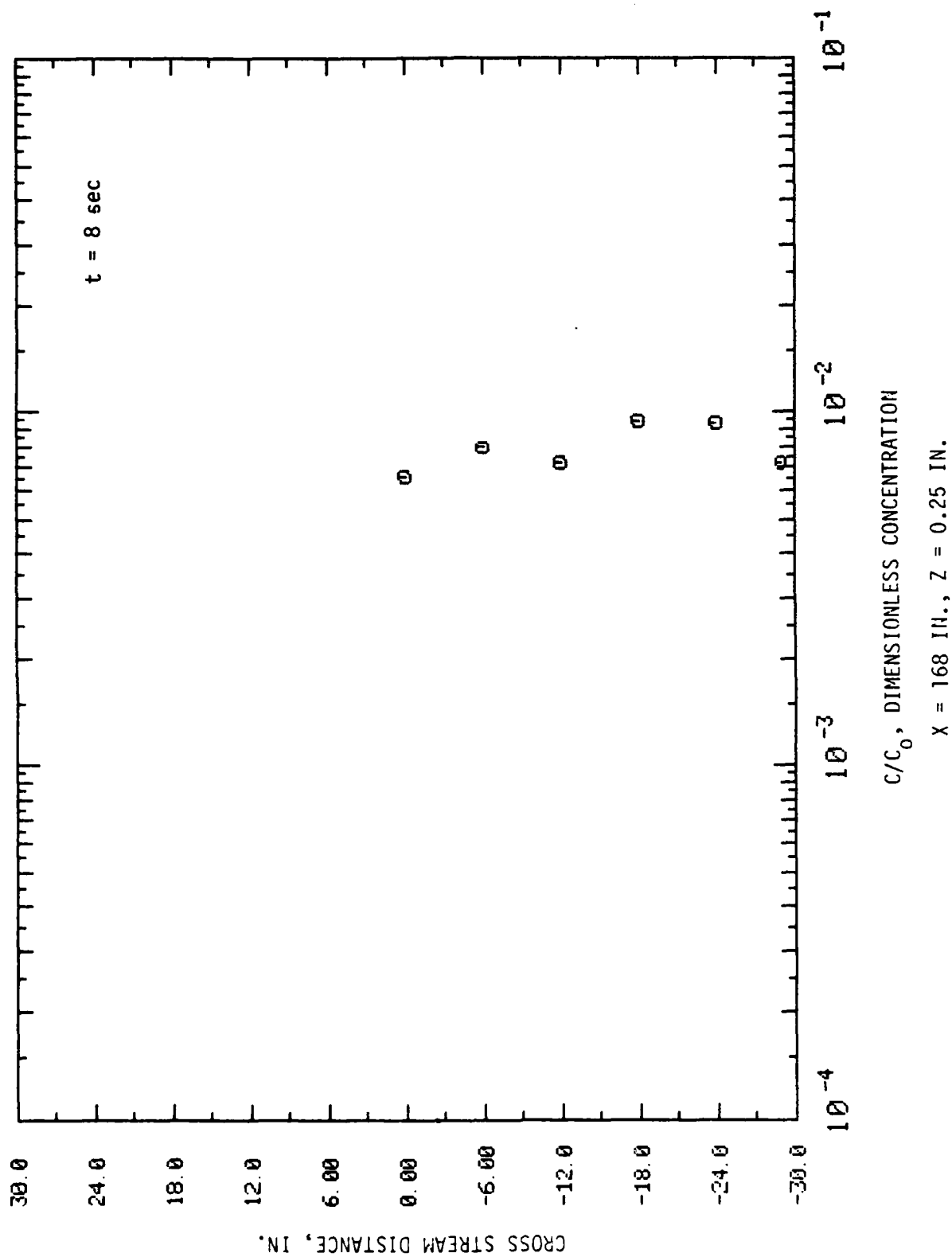
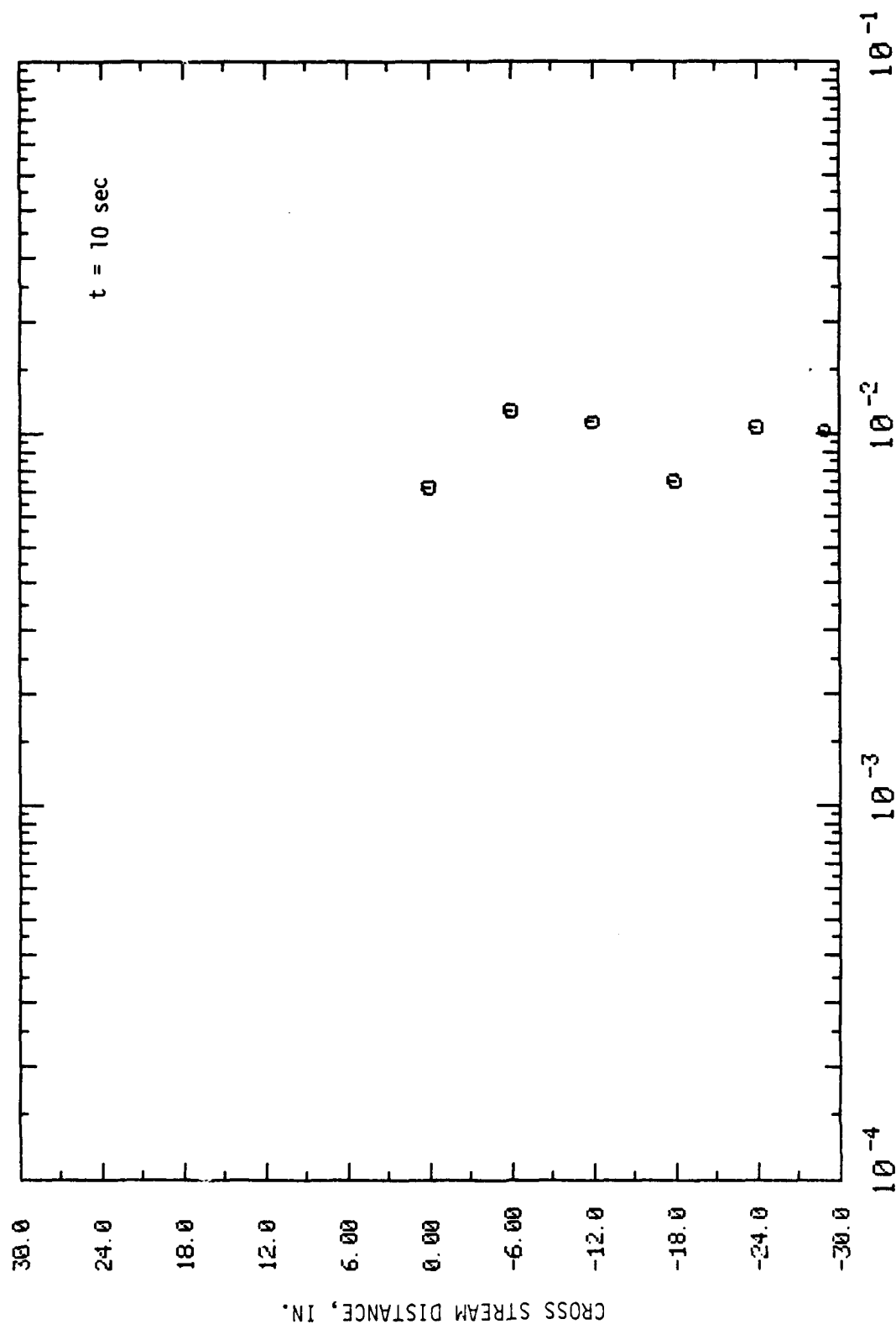


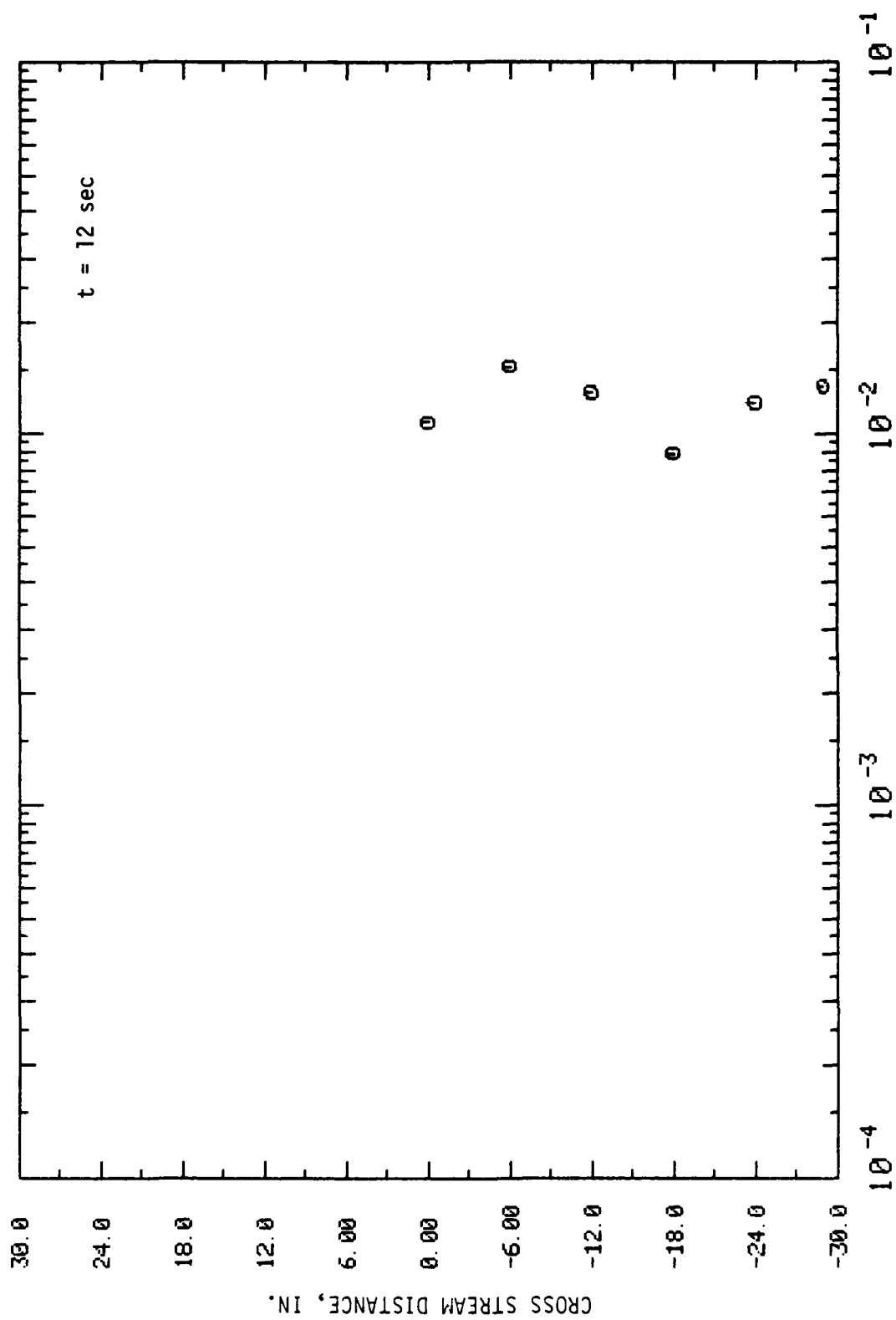
FIGURE B-6 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-7 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-8 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE

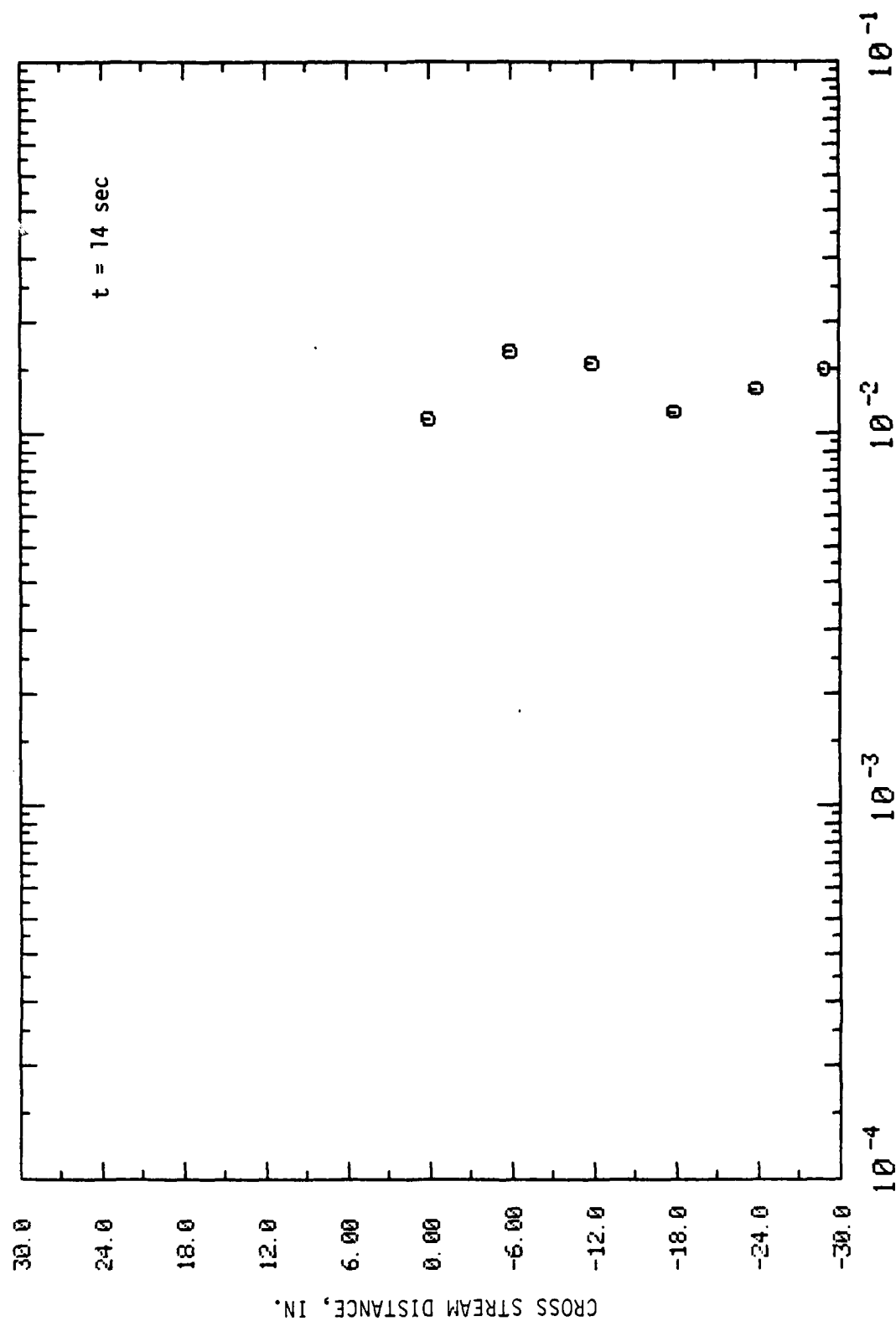


FIGURE B-9 . RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

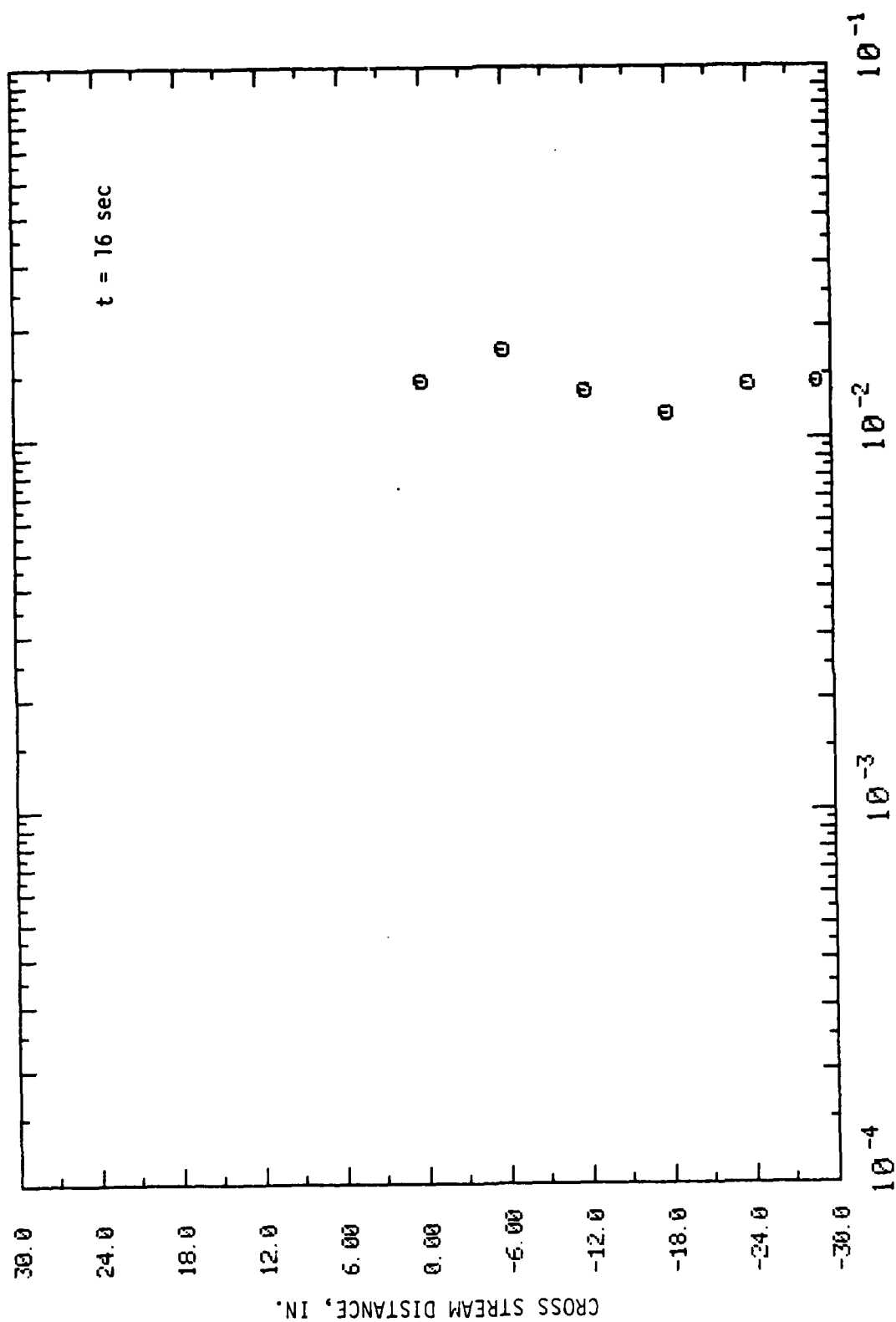


FIGURE B-10. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

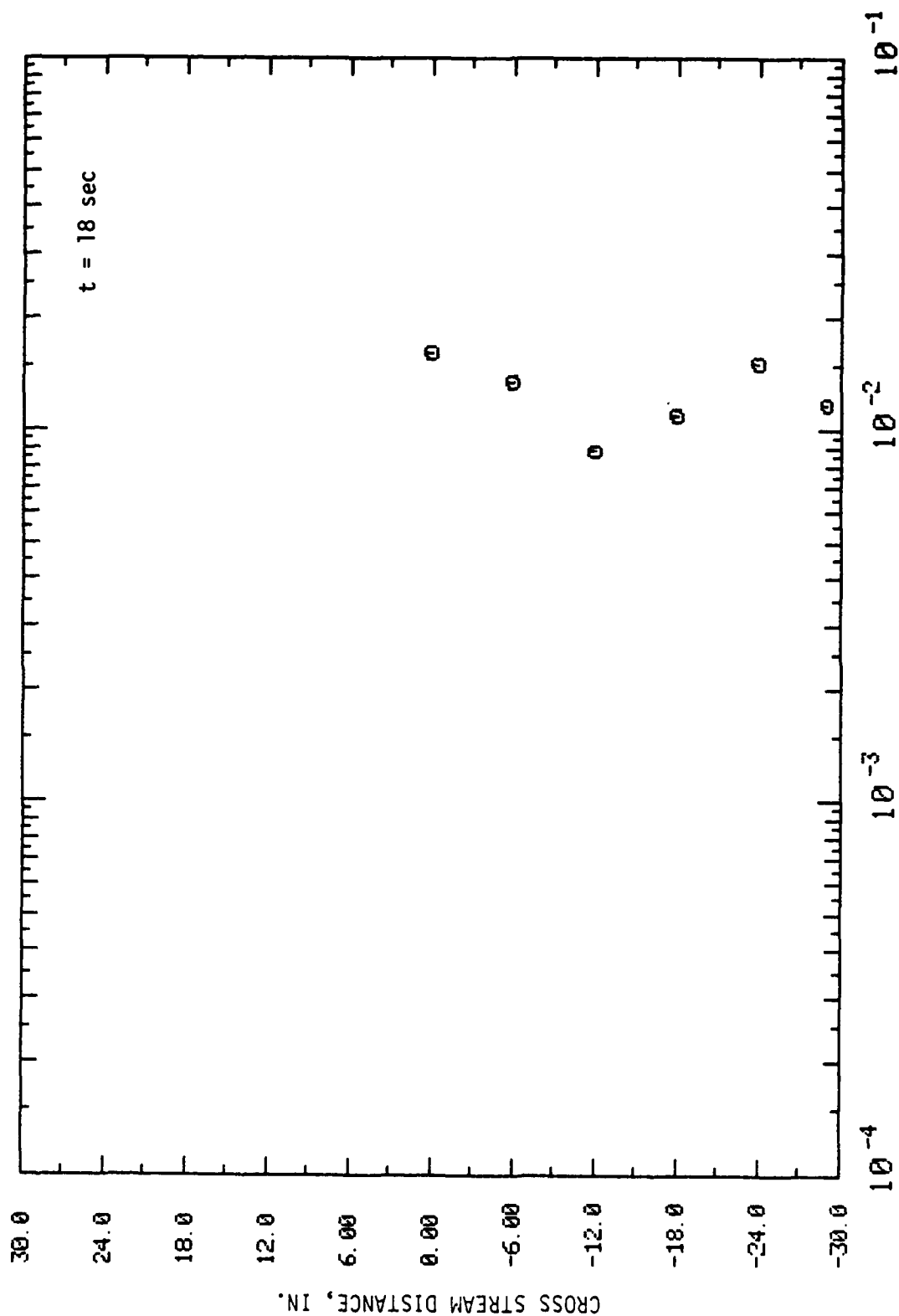
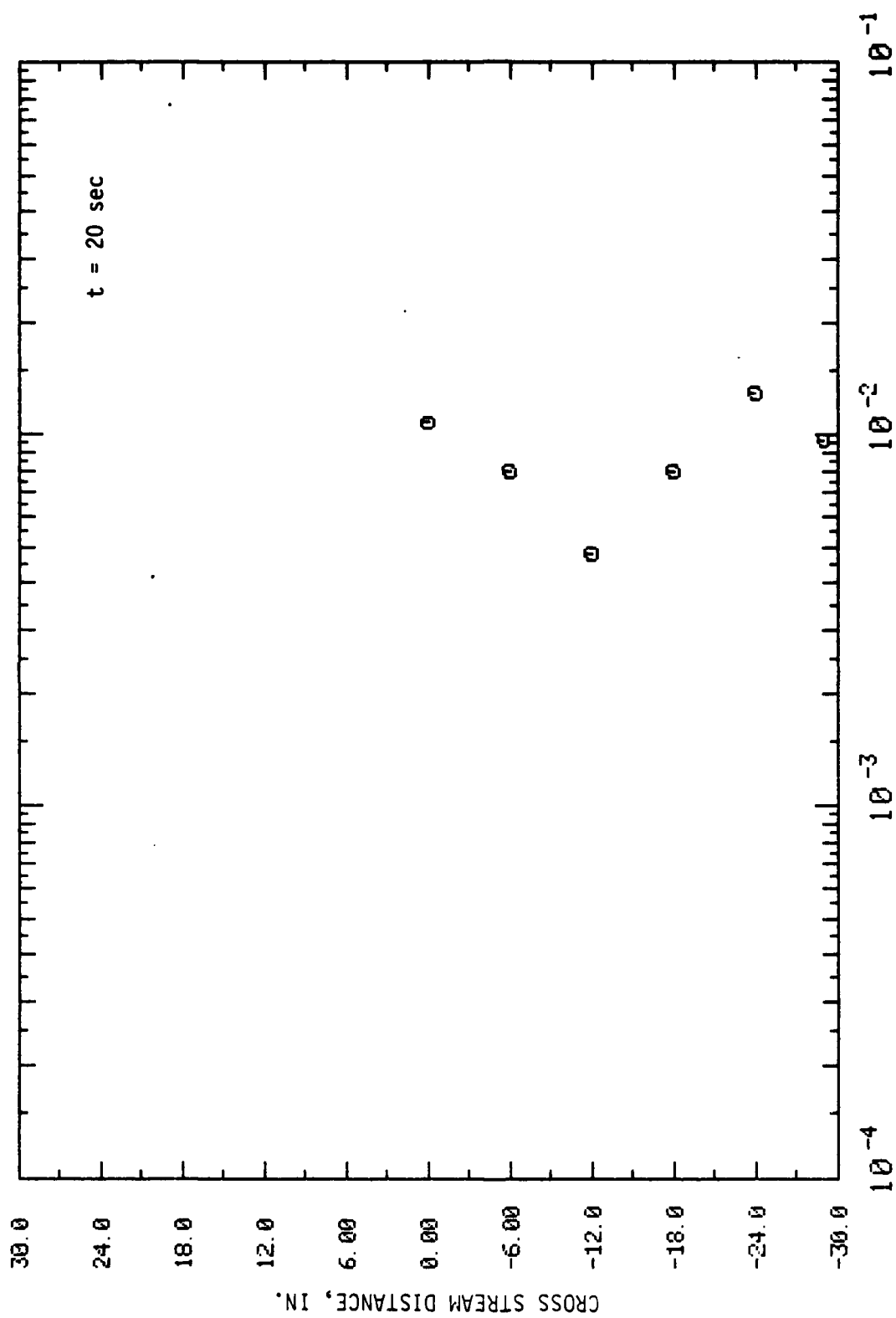


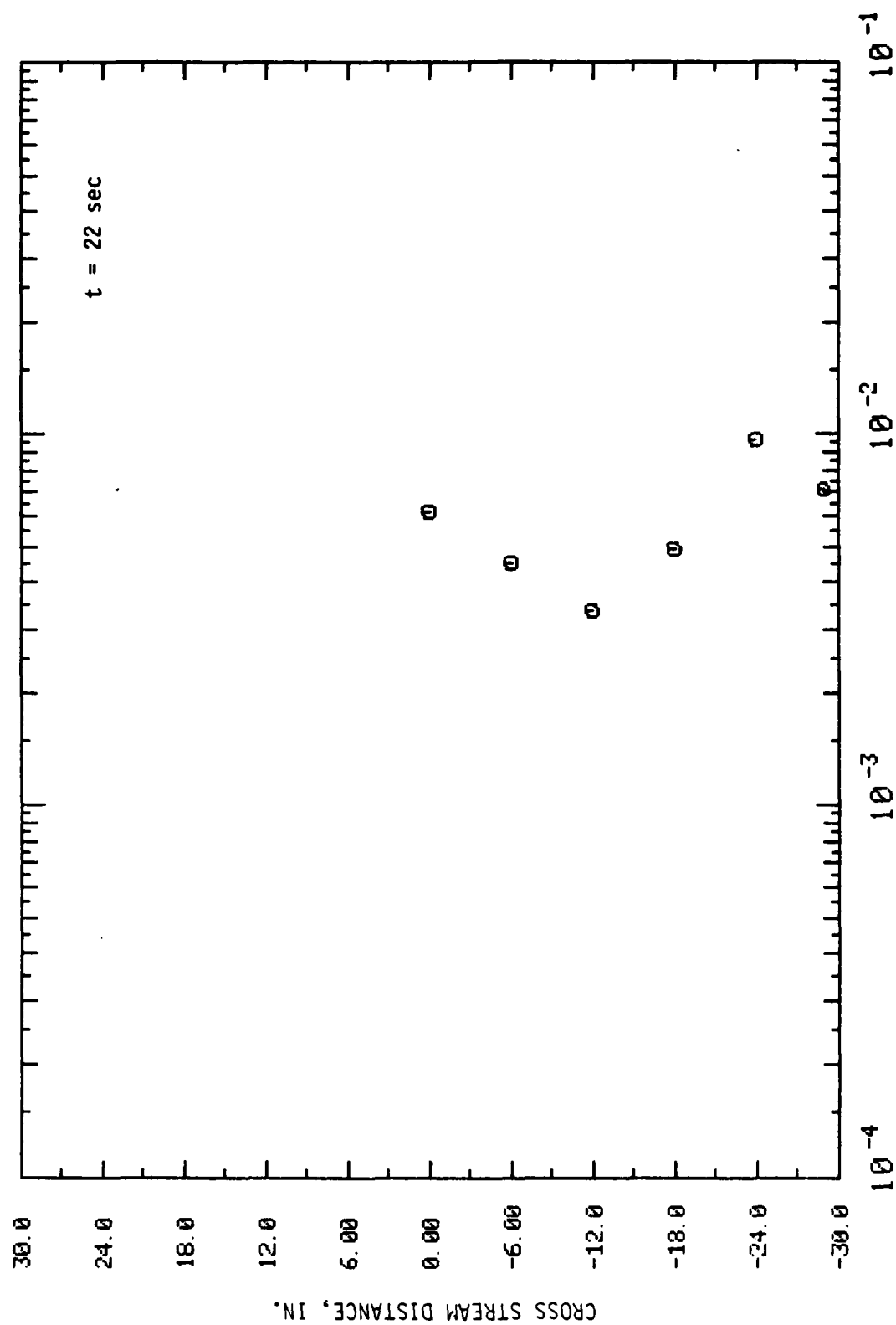
FIGURE B-11. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 0.25$ IN.

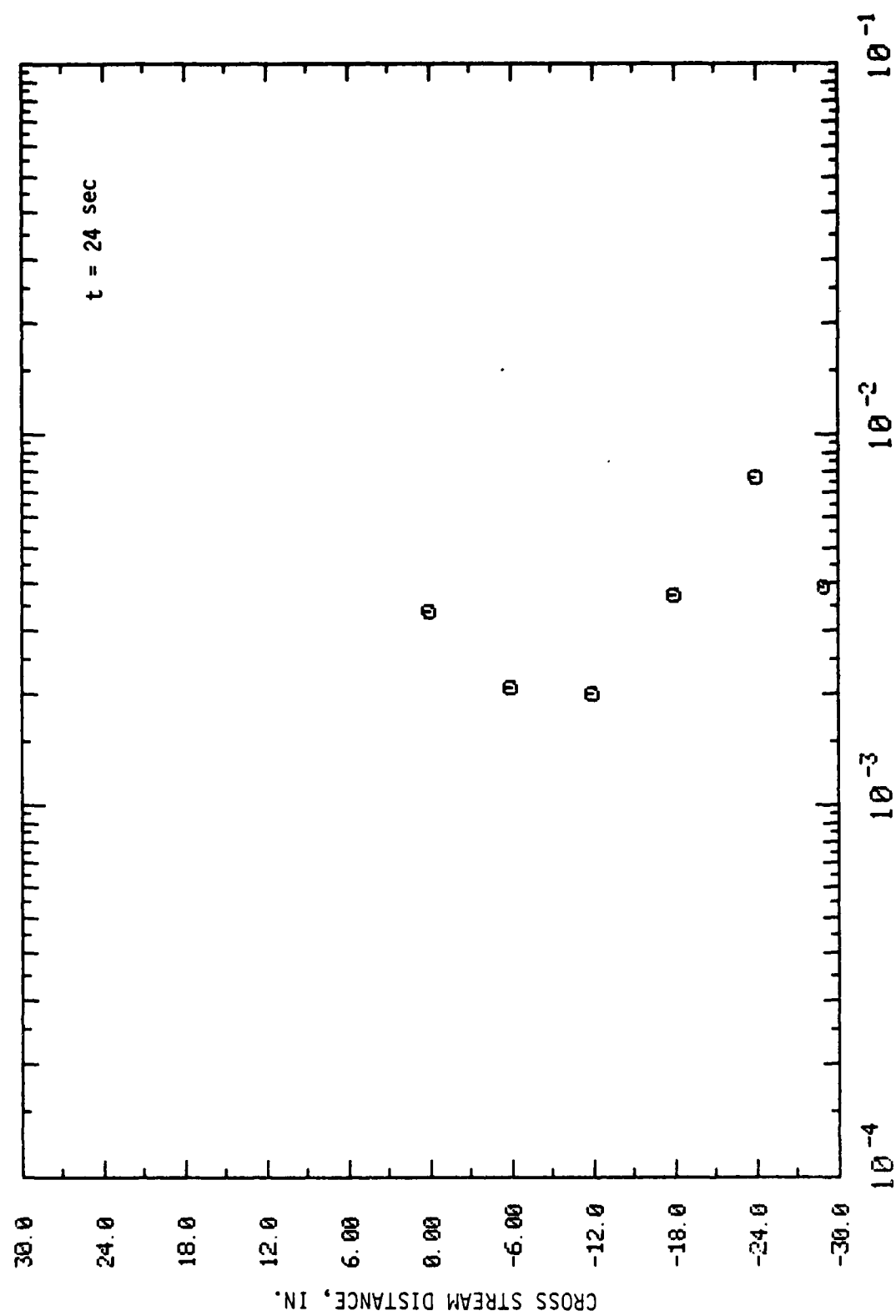
FIGURE B-12. RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

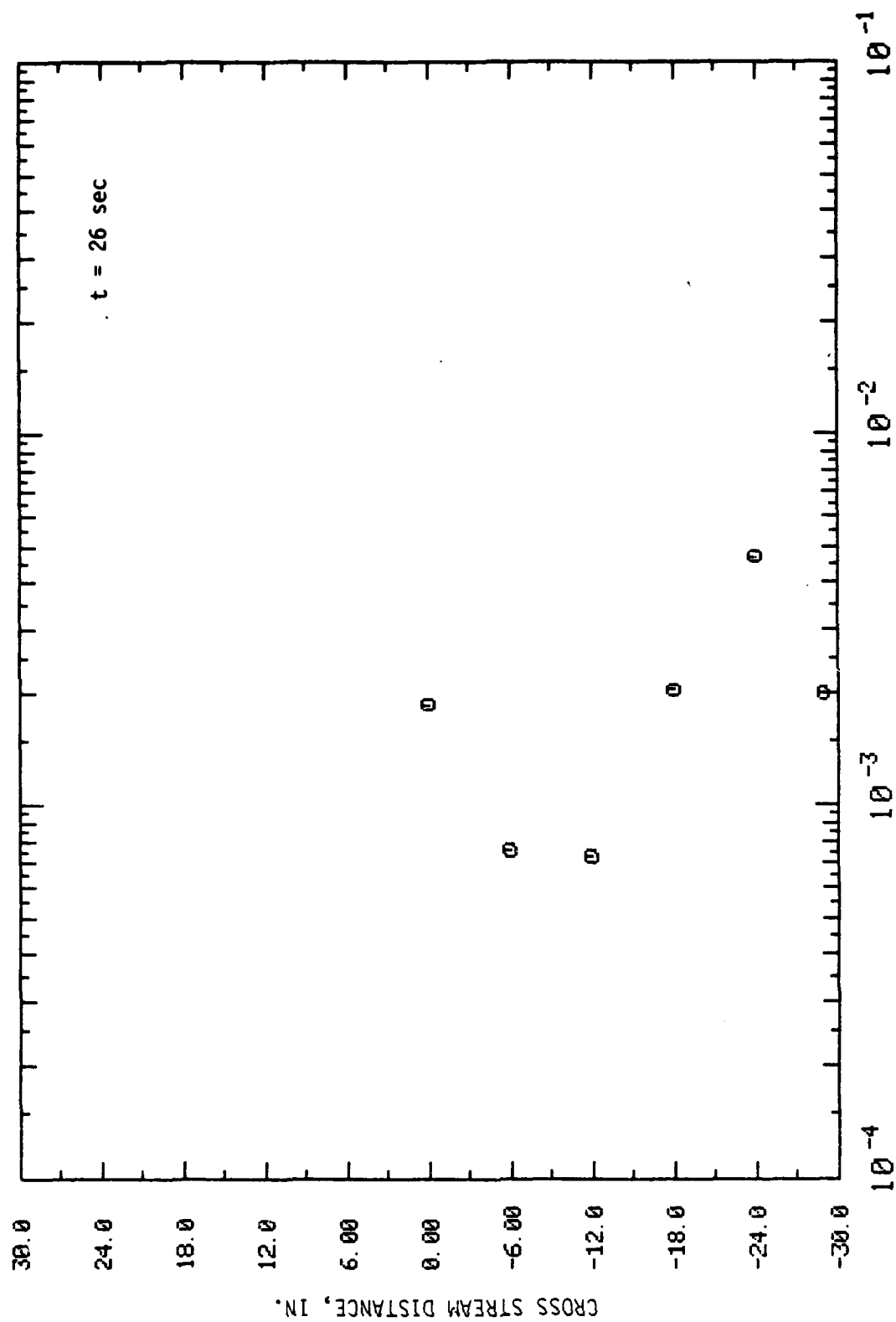
FIGURE B-13. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-14. RUN 11.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$x = 168 \text{ IN.}, z = 0.25 \text{ IN.}$

FIGURE B-15. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

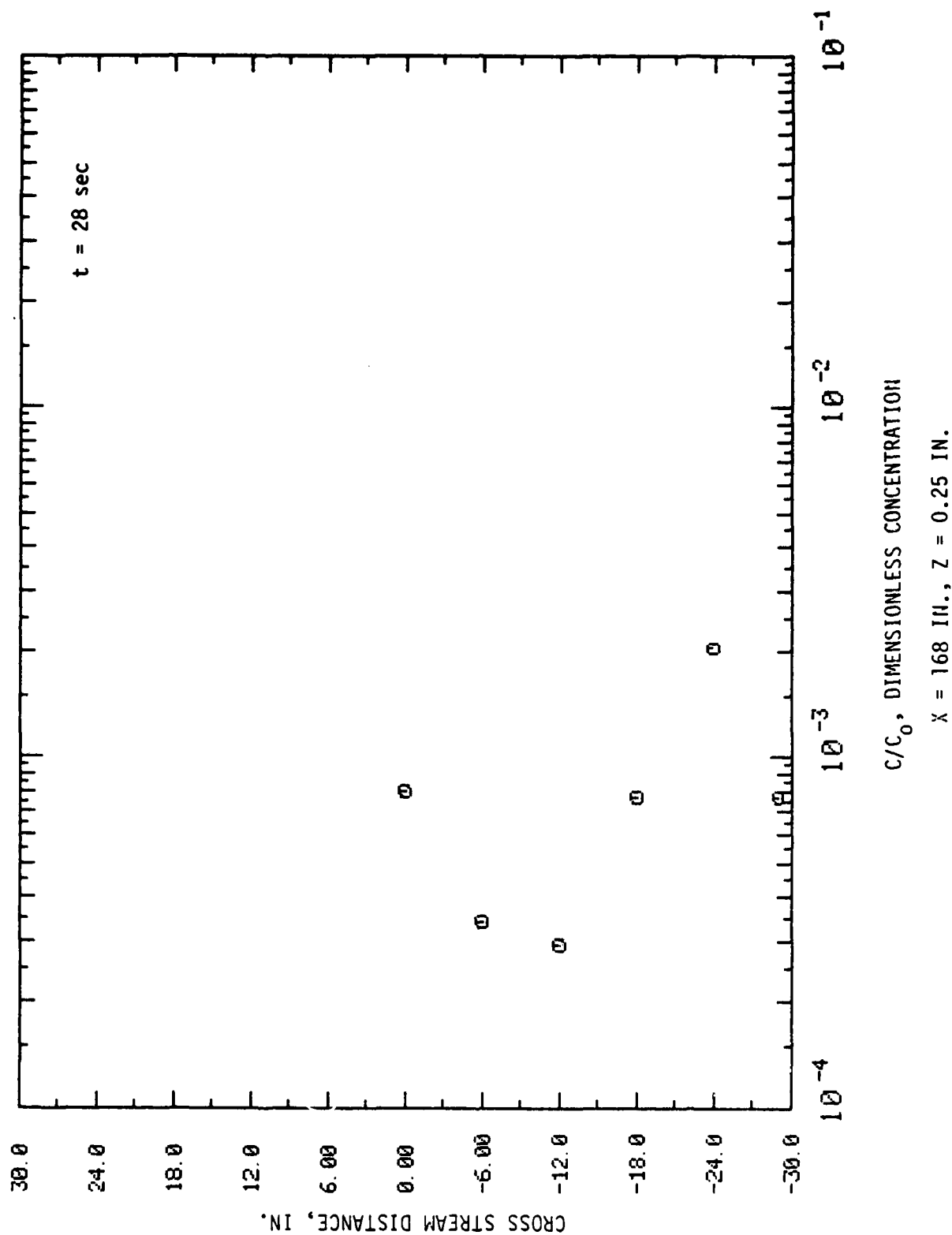
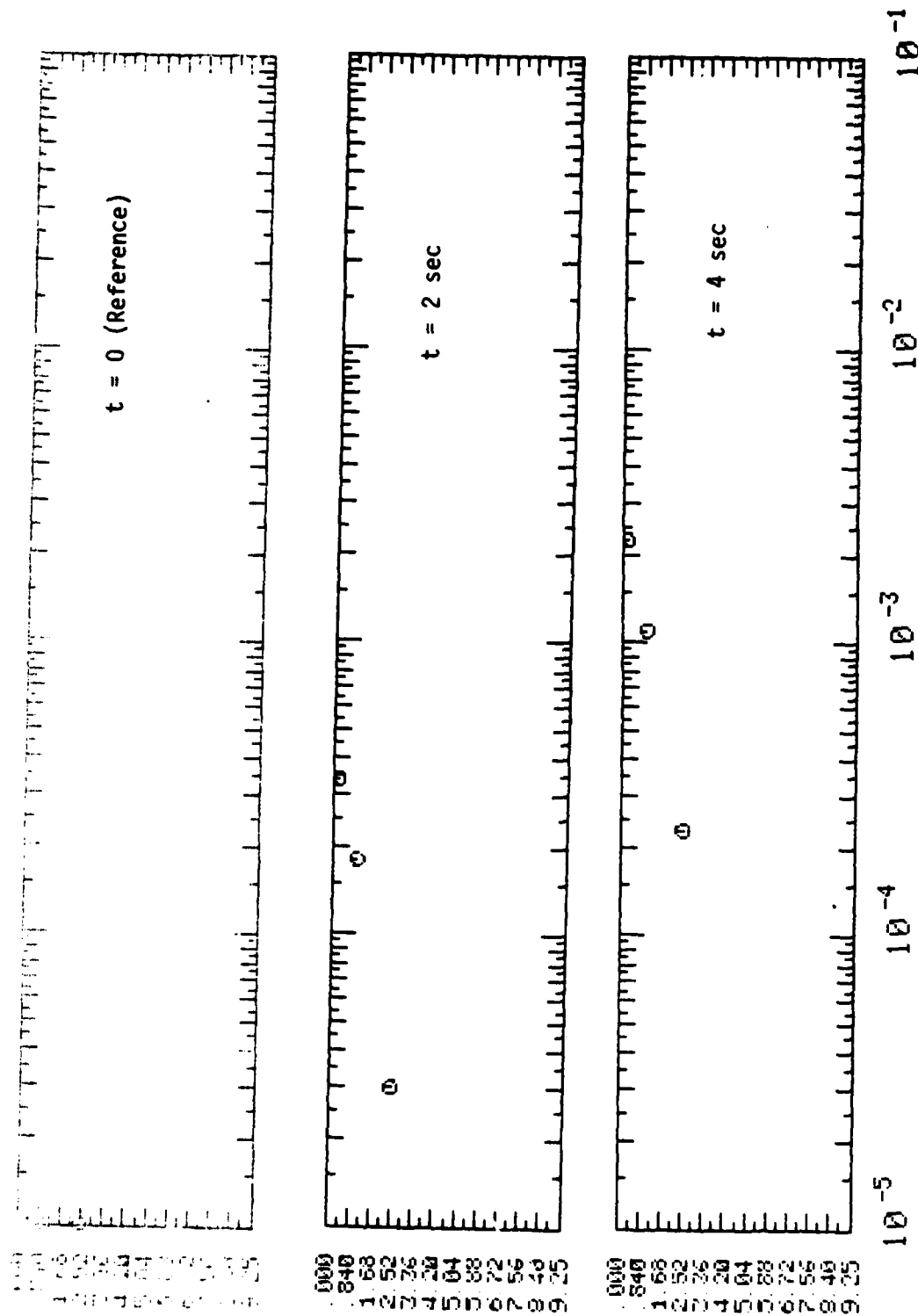


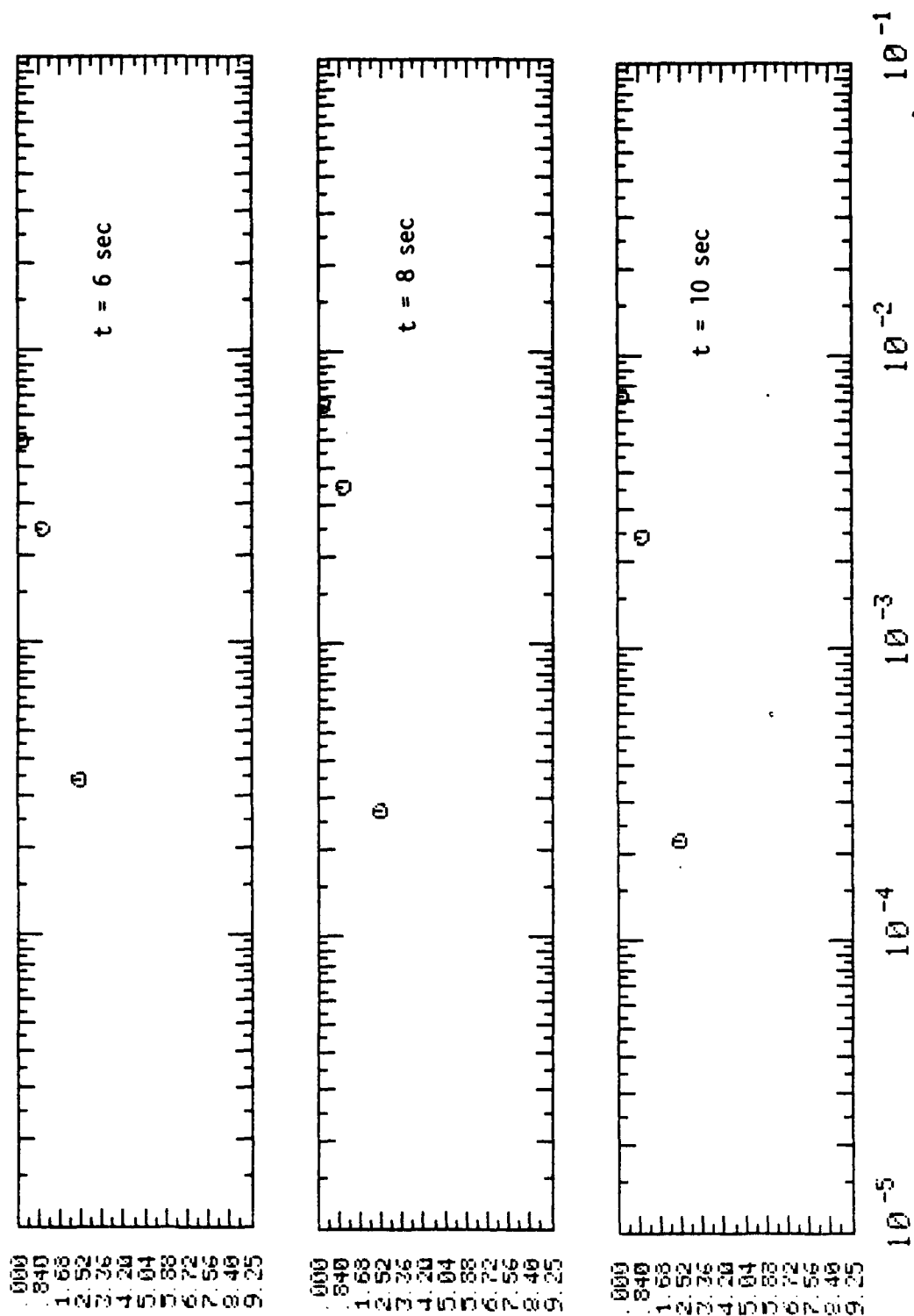
FIGURE B-16. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

DISTANCE FROM FREE SURFACE, IN.

C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

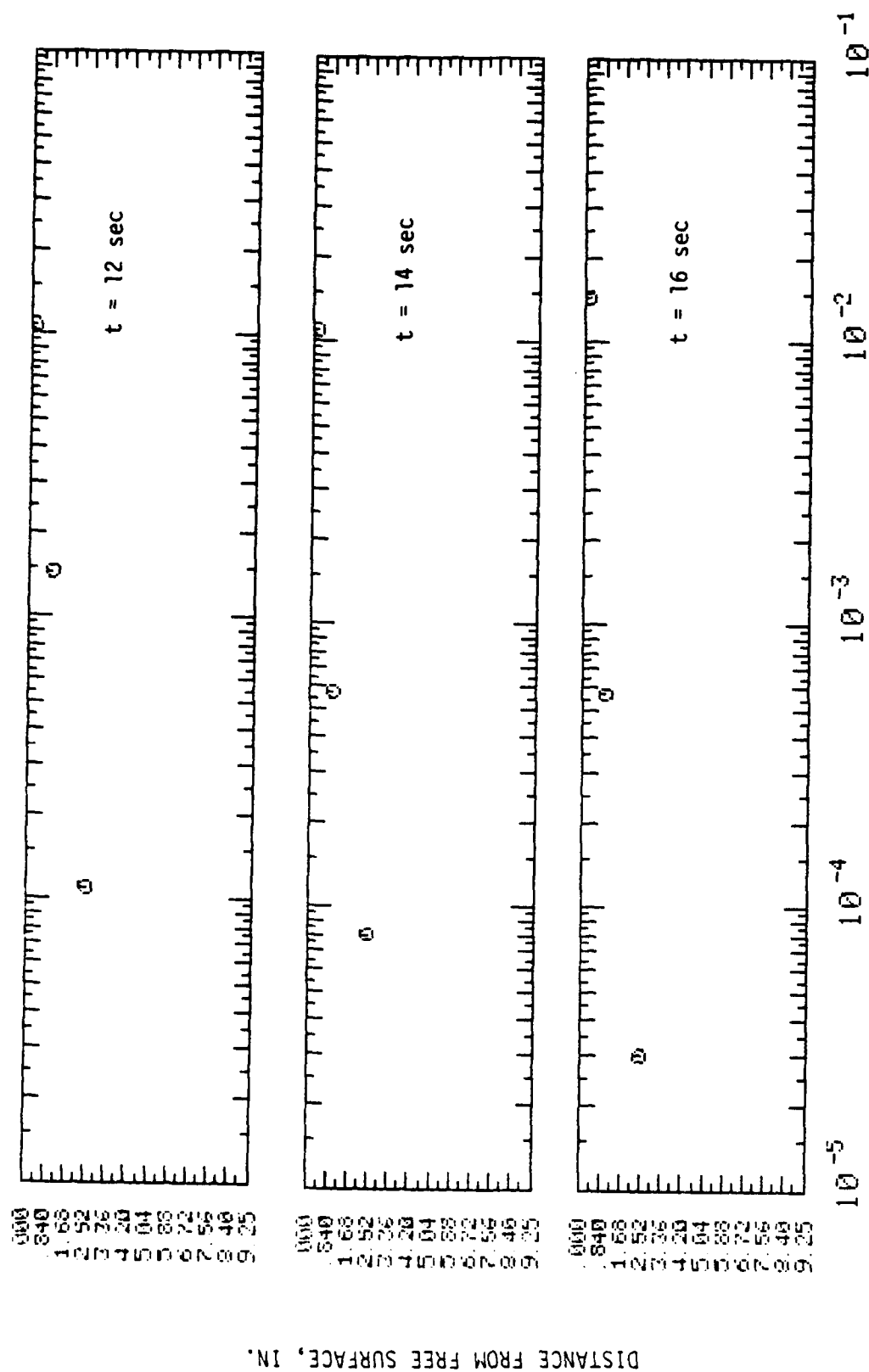
FIGURE B-17. RUN 11.1-2 VERTICAL CONCENTRATION PROFILES



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

FIGURE B-18. RUN 11.1-2 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE B-19. RUN II.1-2 VERTICAL CONCENTRATION PROFILES

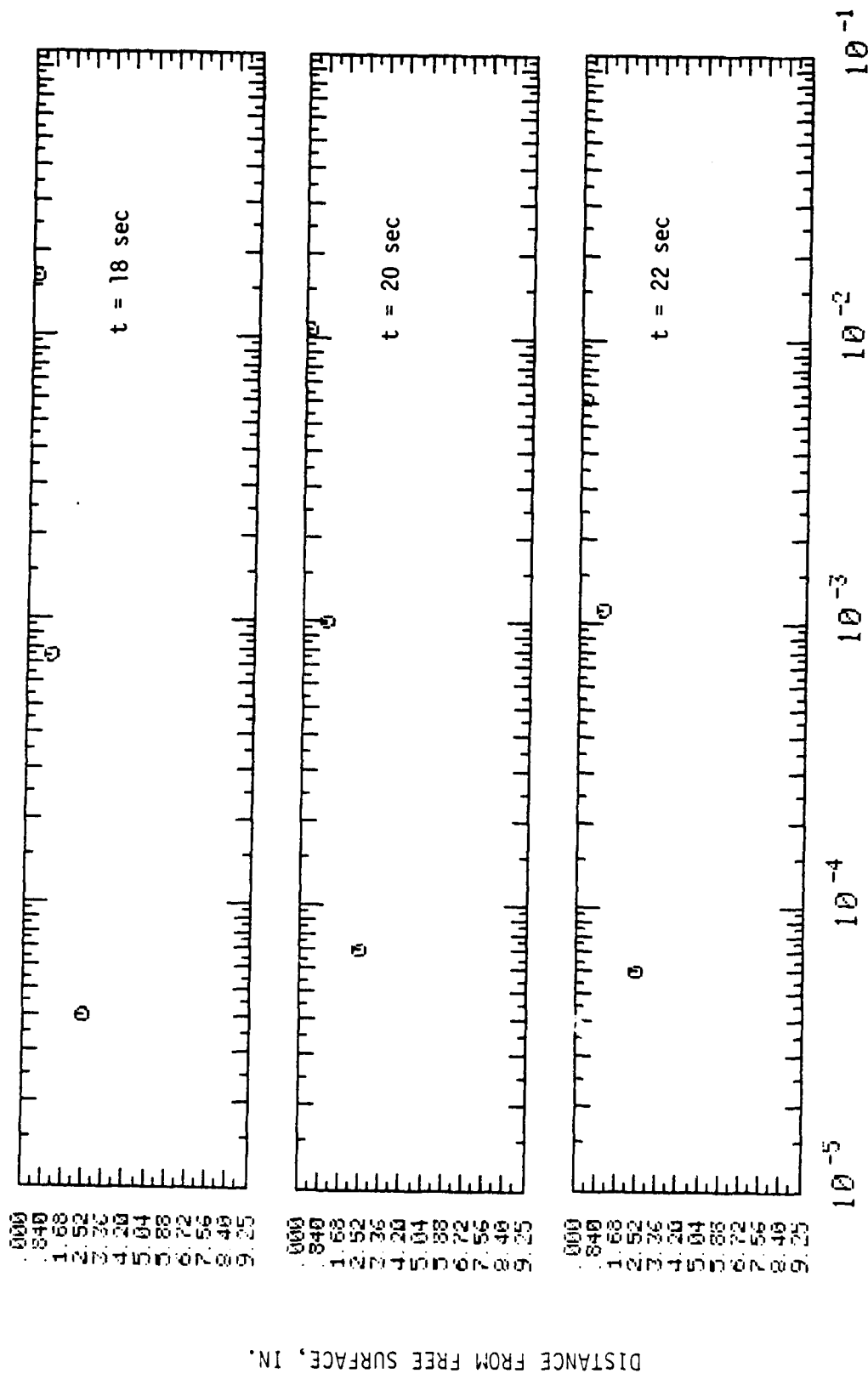
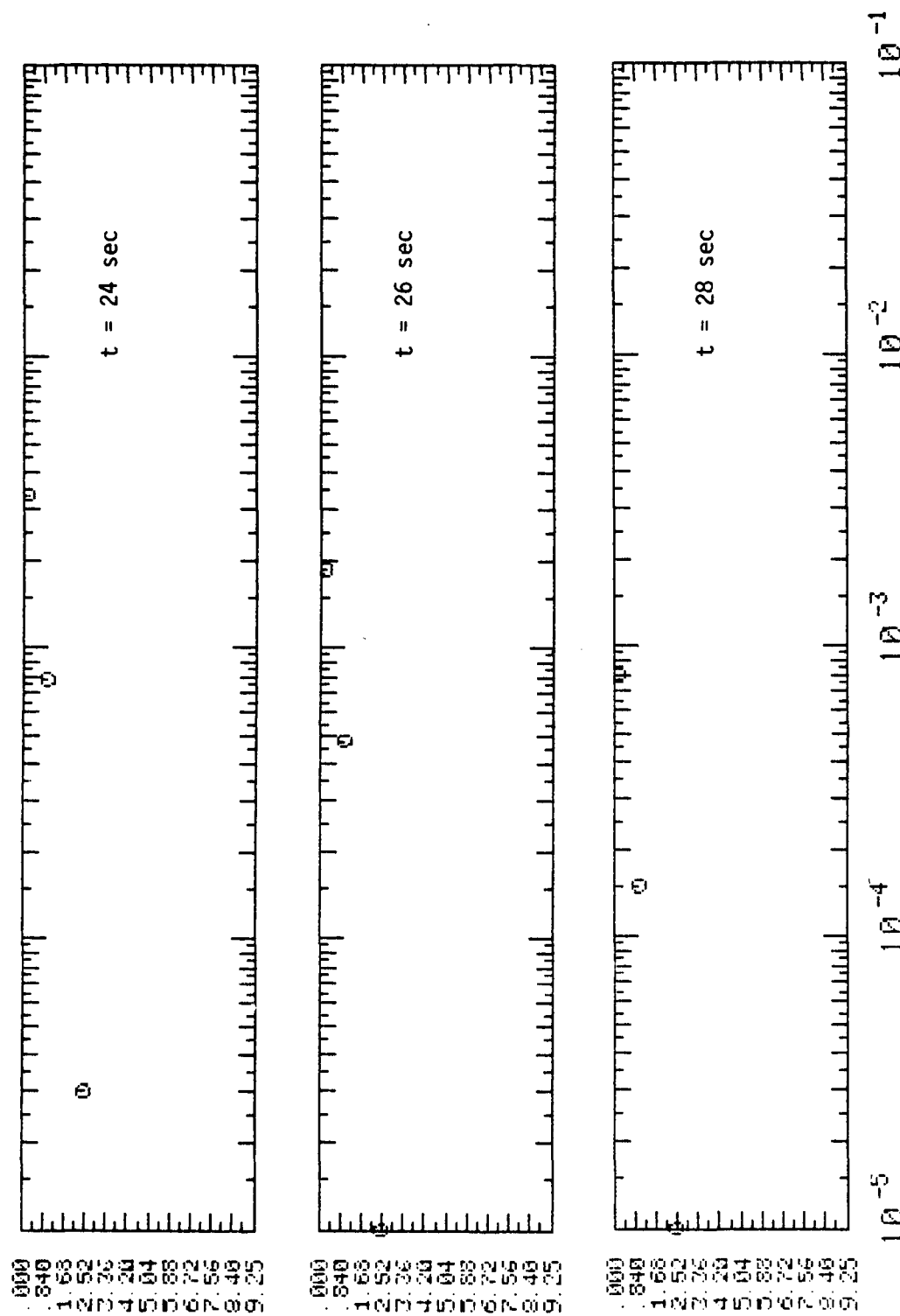


FIGURE B-20. RUN II.1-2 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

B-21



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE B-21. RUN II.1-2 VERTICAL CONCENTRATION PROFILES

APPENDIX C
CONCENTRATION PROFILES FOR
RUN II.1-7A

$$\rho_c/\rho = 1.05 \text{ (Sucrose)}$$

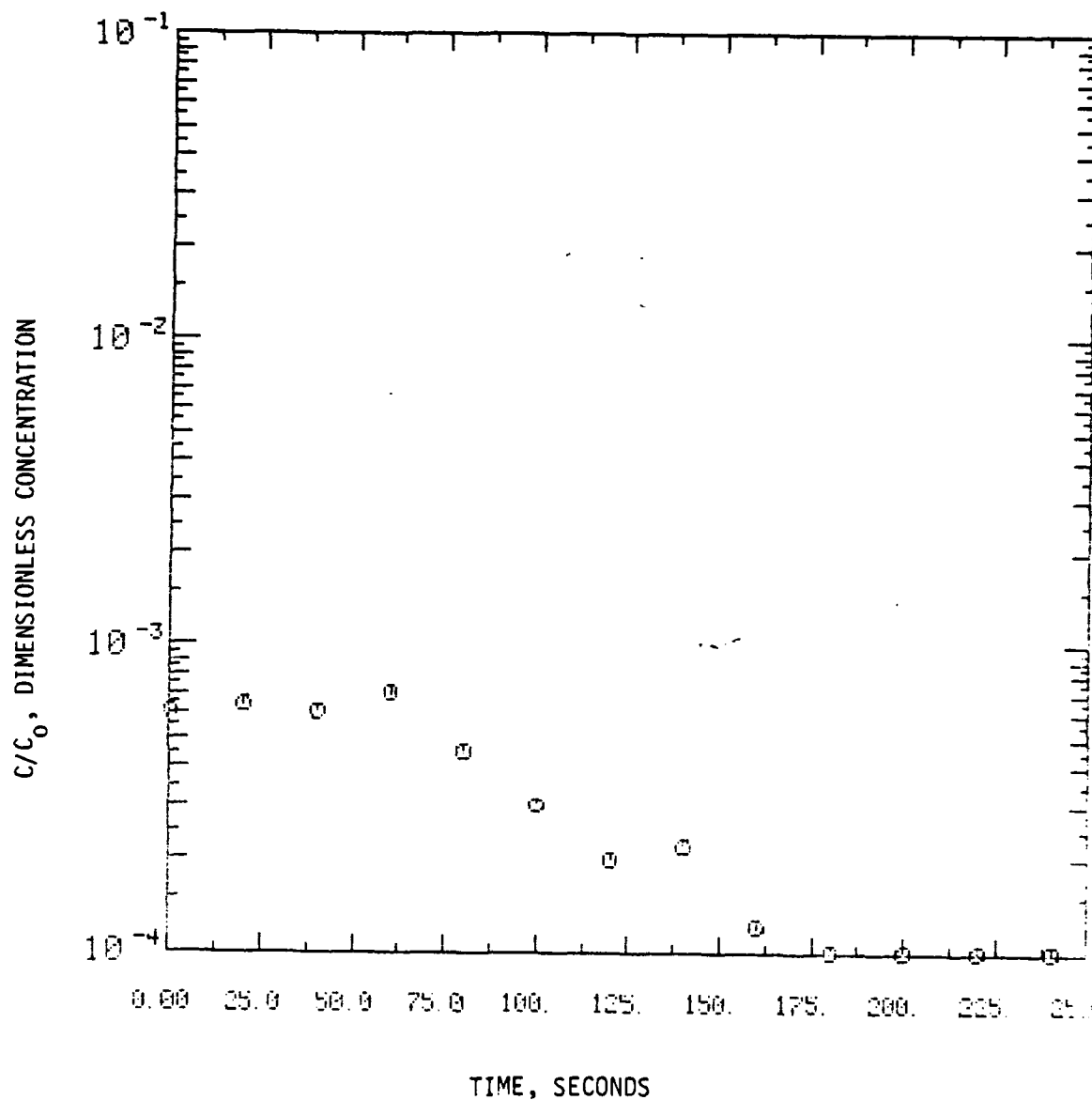
$$r_i/d = 0.125$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 3.5$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph (horizontal)	145 sec.
cross stream profile	145 sec.
time history graph (vertical)	103 sec.
vertical profile	103 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

FIGURE C-1. RUN II.1-7A (HORIZONTAL) CONCENTRATION TIME HISTORY

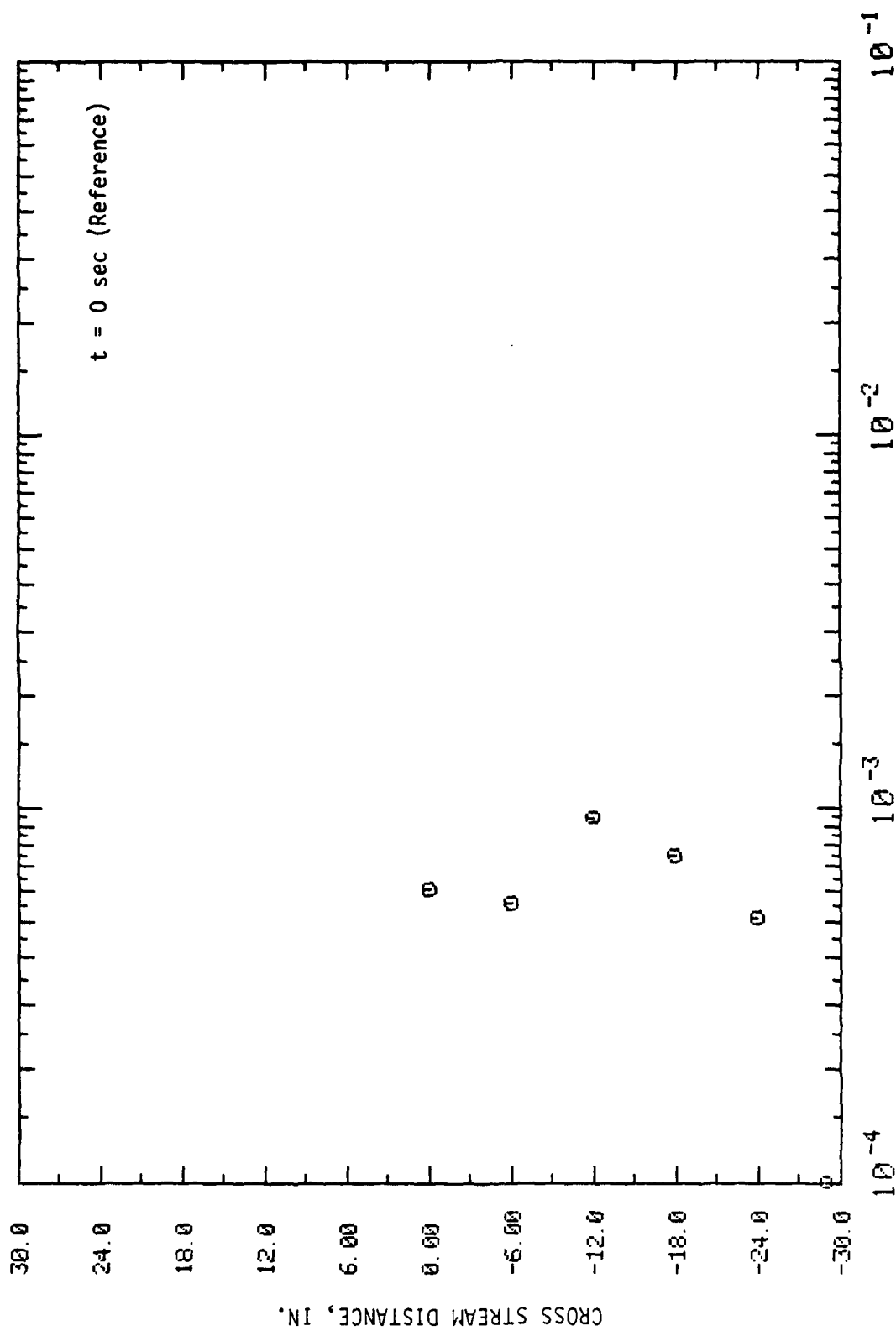


FIGURE C-2. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

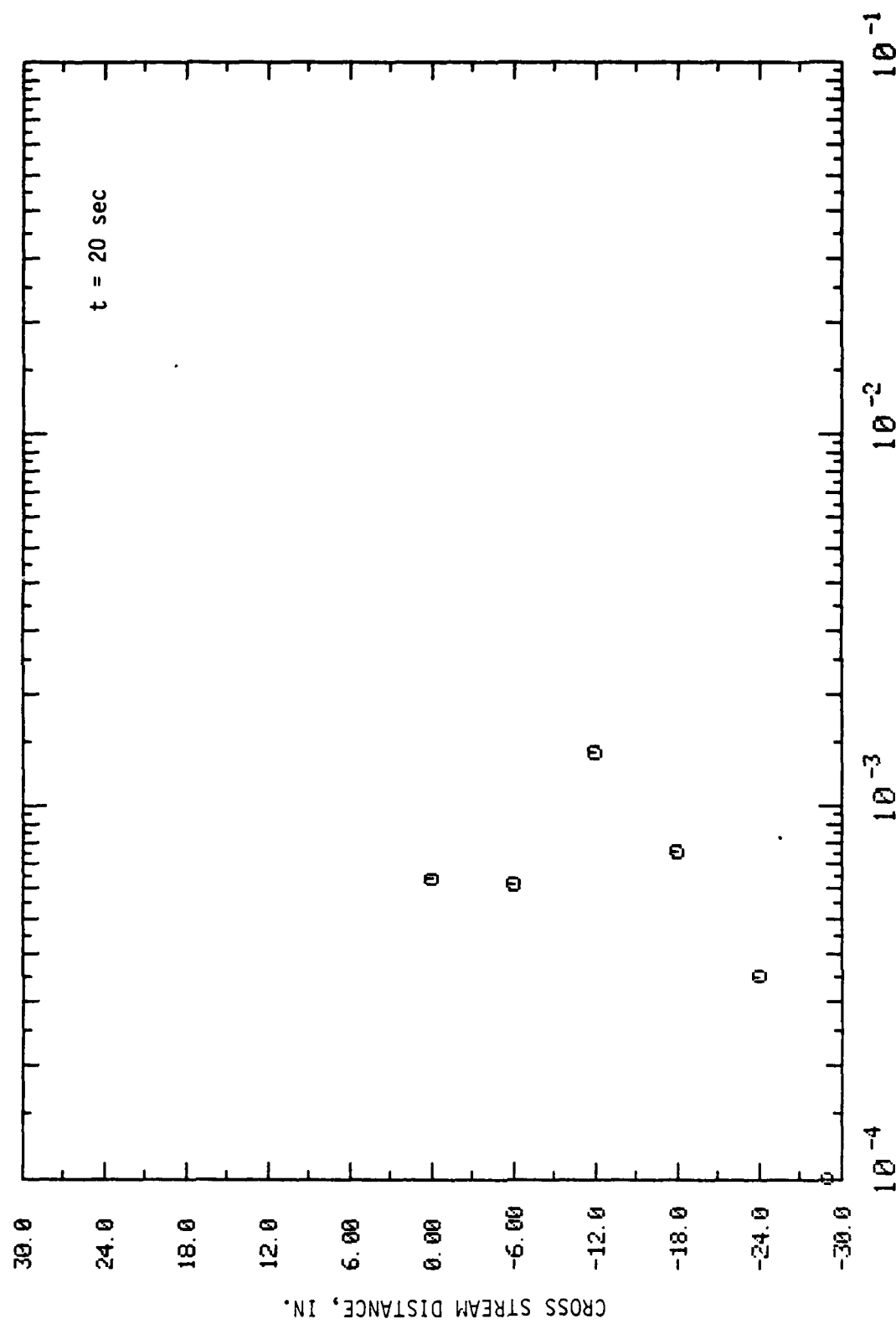


FIGURE C-3. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

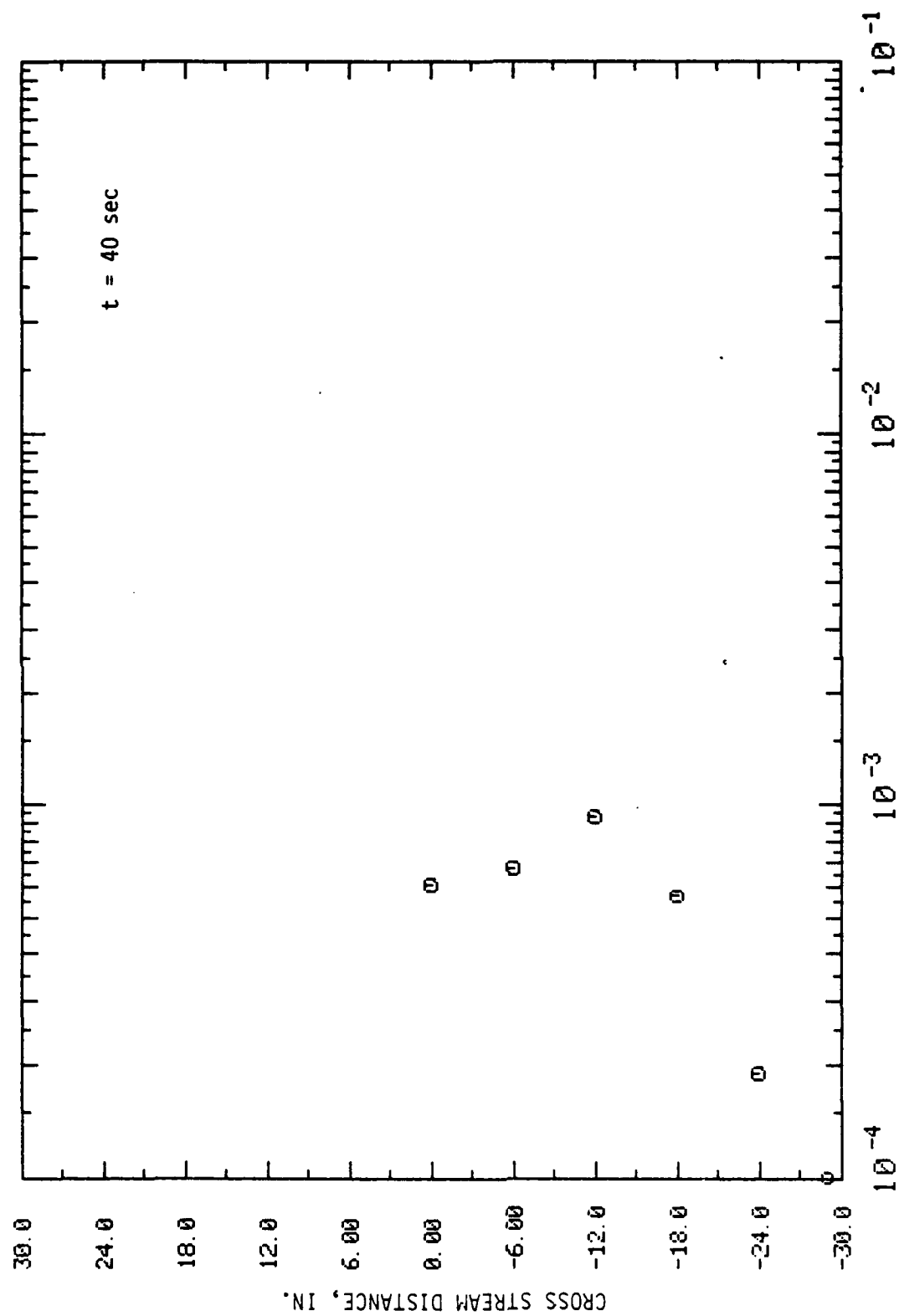


FIGURE C-4. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

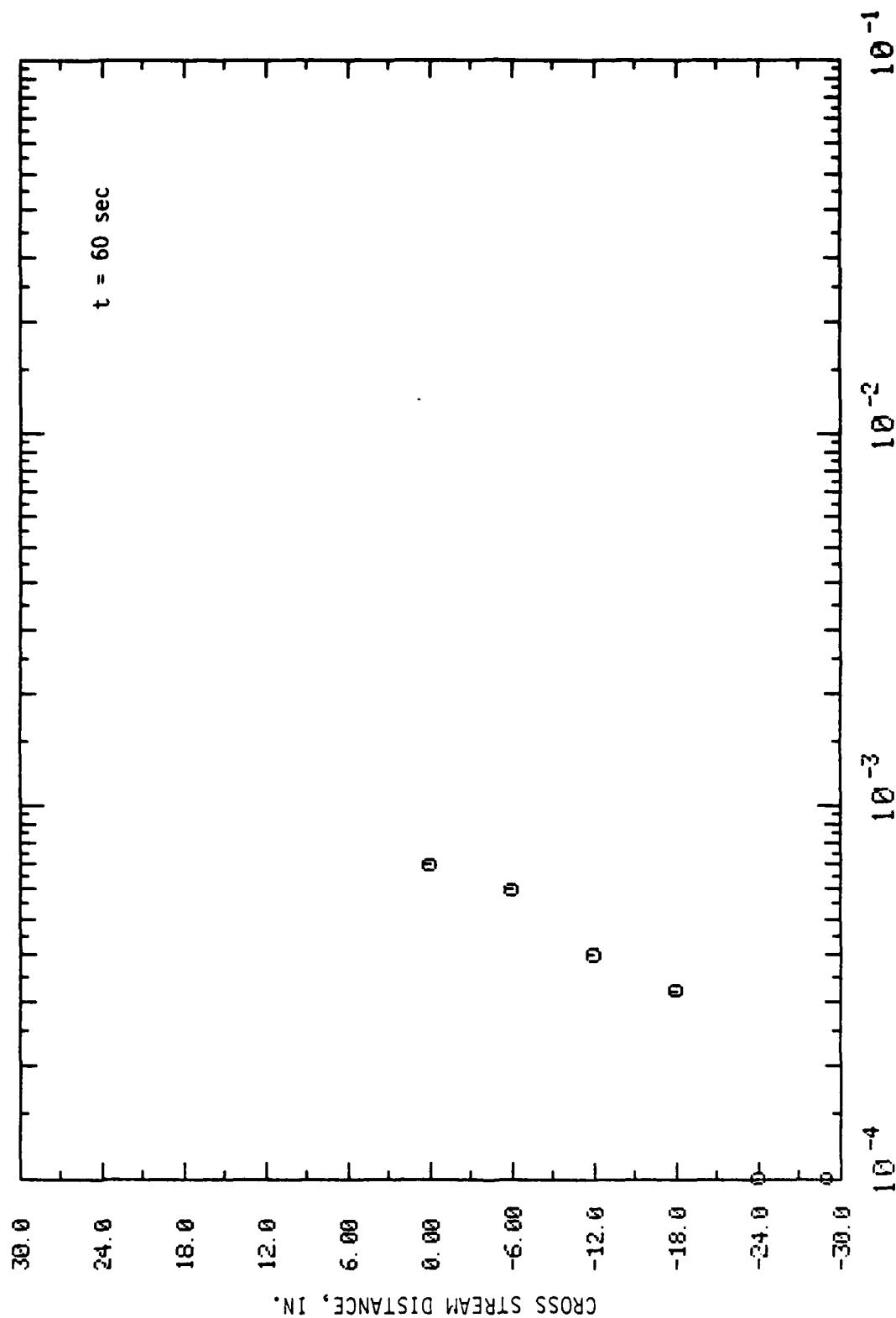


FIGURE C-5. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

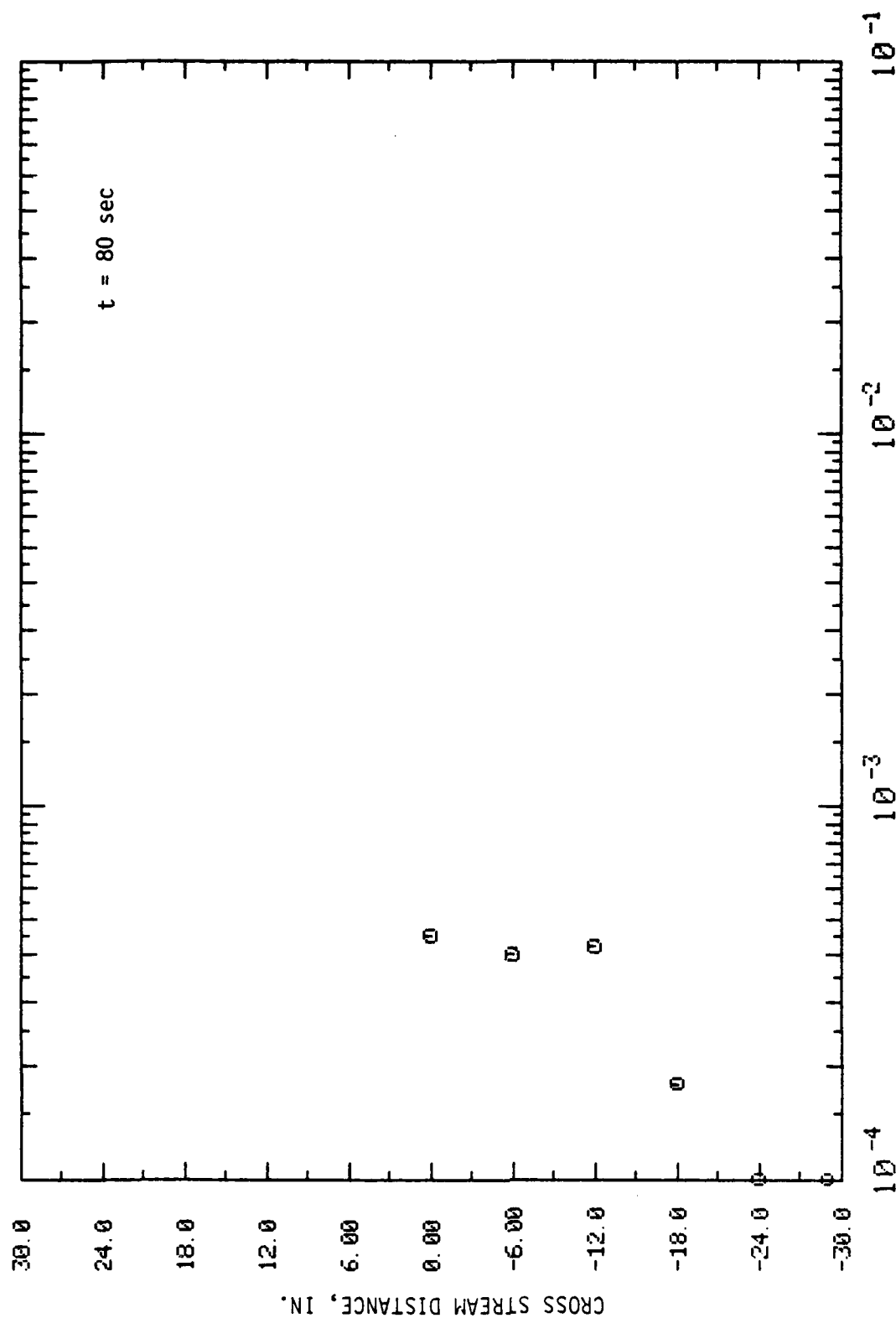


FIGURE C-6. RUN 11.1-7A CROSS STREAM CONCENTRATION PROFILE

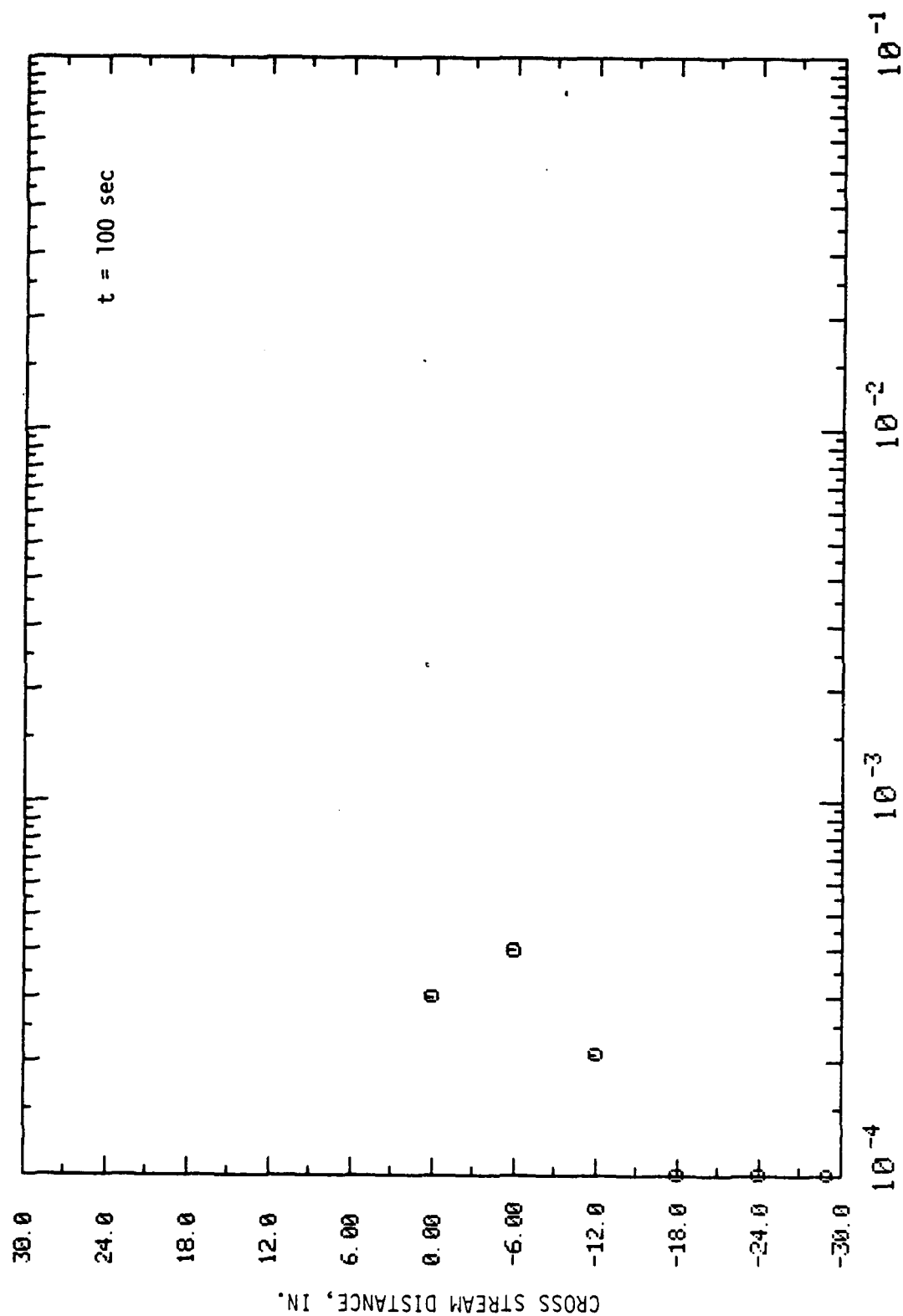


FIGURE C-7. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

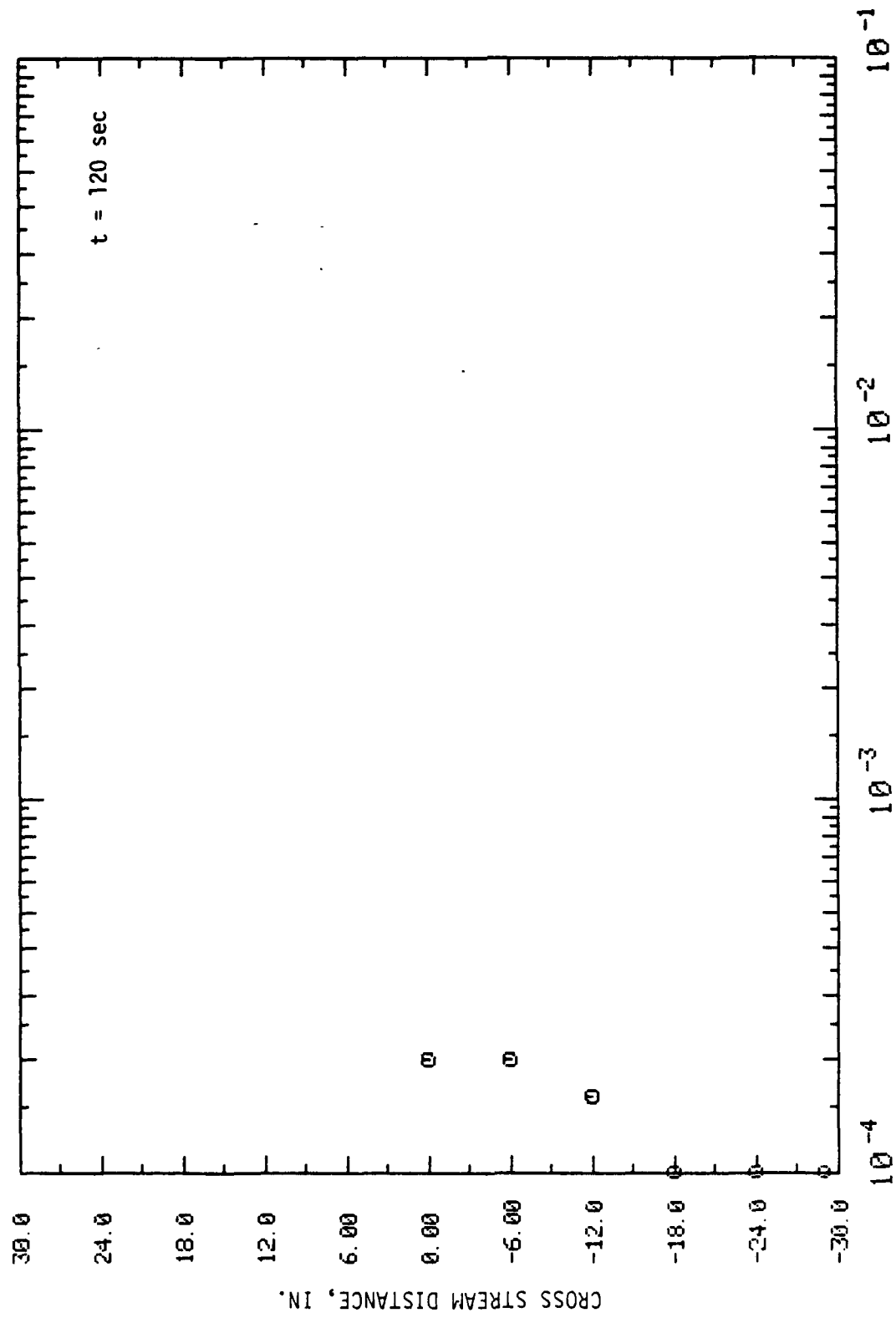
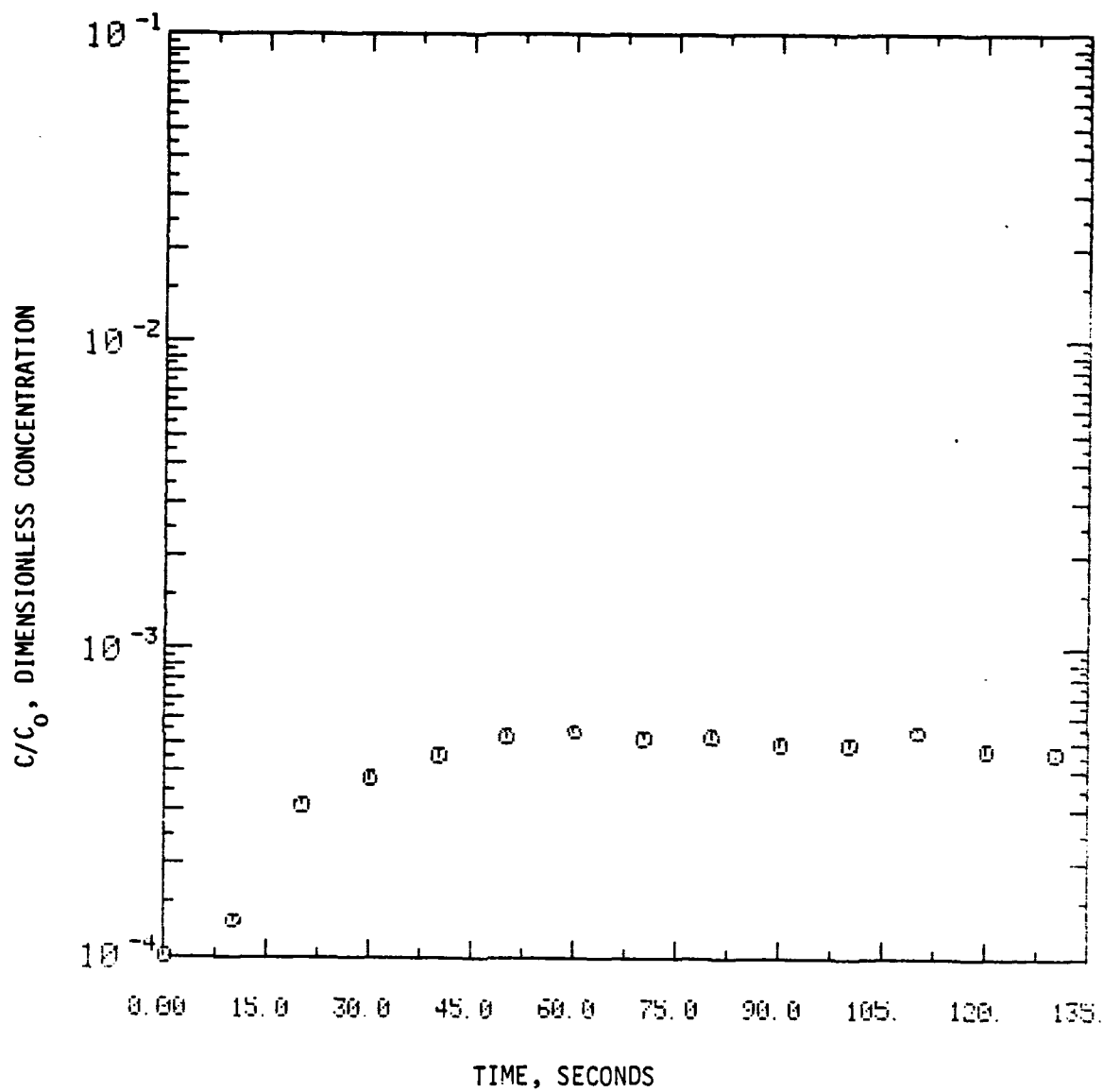


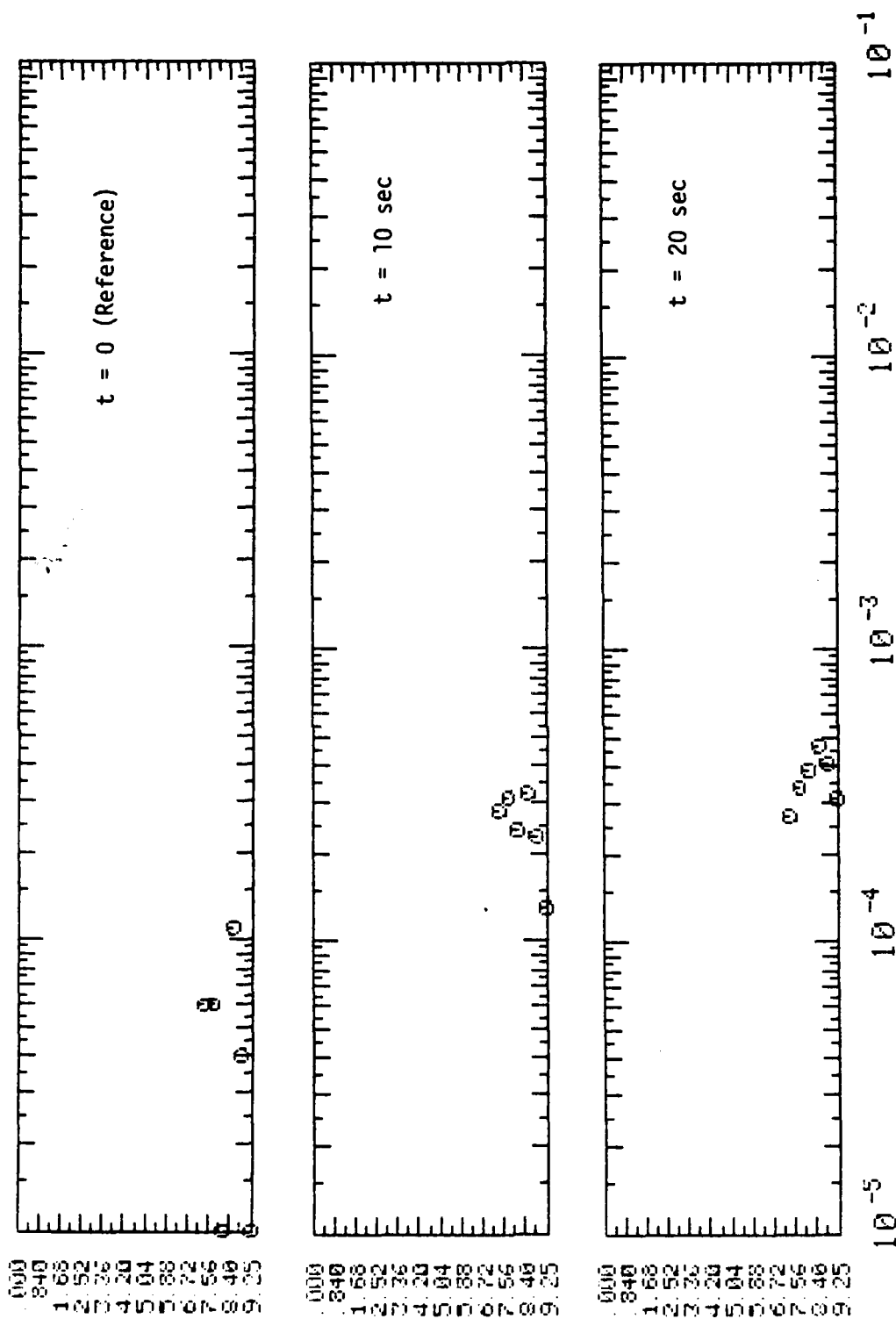
FIGURE C-8. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE



X = 168 IN., Y = 0, Z = 9.25 IN.

FIGURE C-9. RUN II.1-7A (VERTICAL) CONCENTRATION TIME HISTORY

DISTANCE FROM FREE SURFACE, IN.

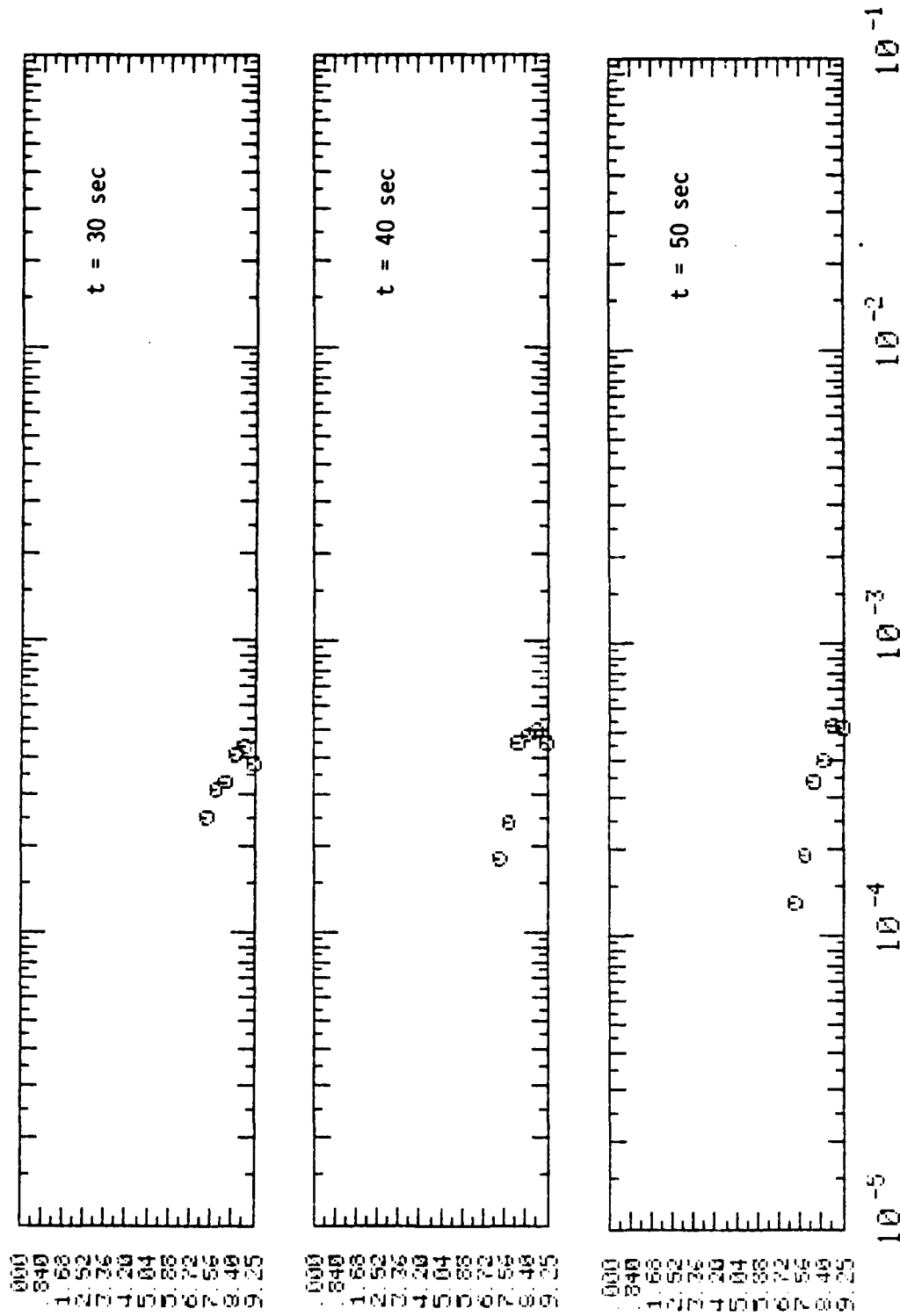


C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE C-10. RUN II.1-7A VERTICAL CONCENTRATION PROFILES

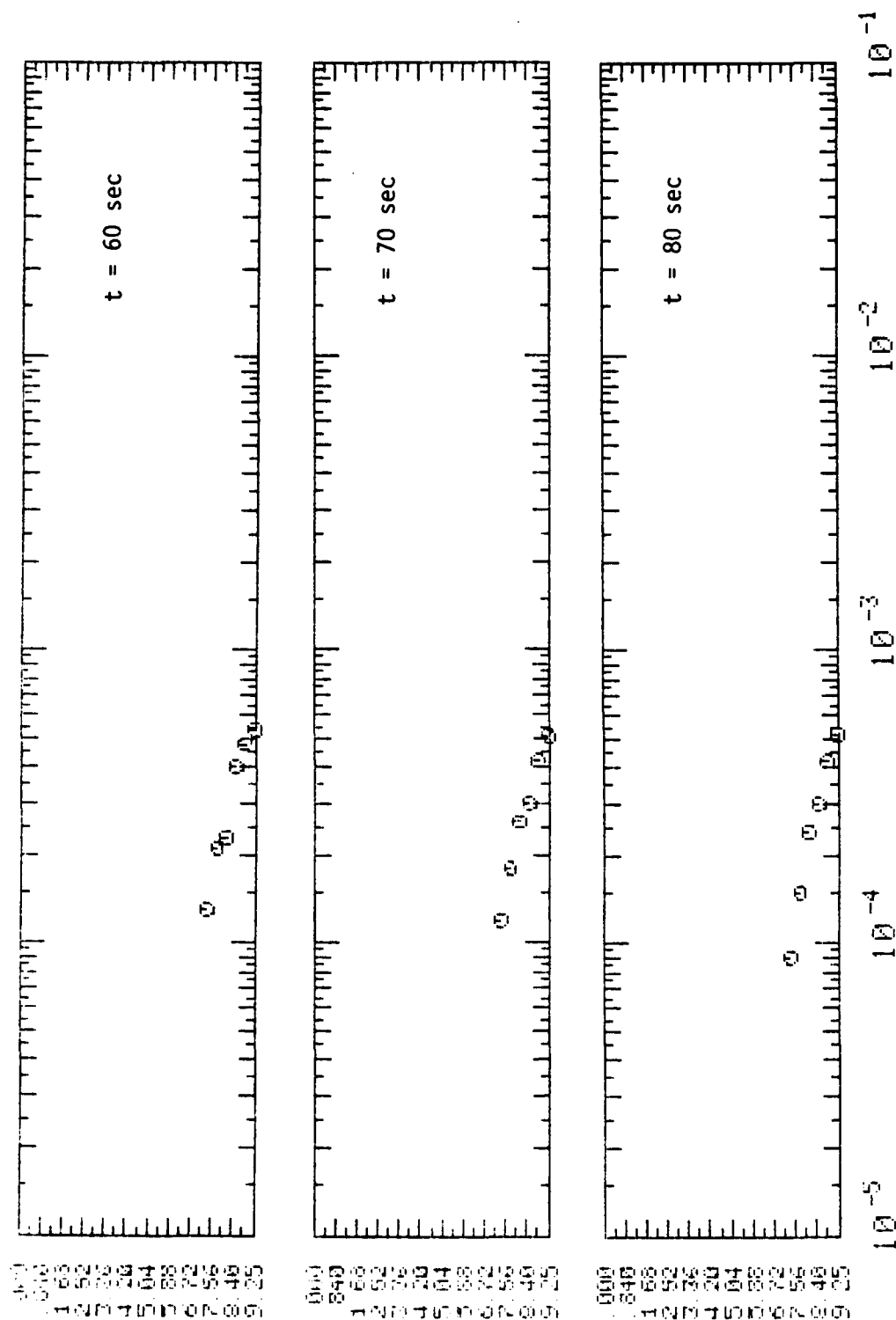
DISTANCE FROM FREE SURFACE, IN.



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE C-11. RUN II.1-7A VERTICAL CONCENTRATION PROFILES



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

FIGURE C-12. RUN II.1-7A VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

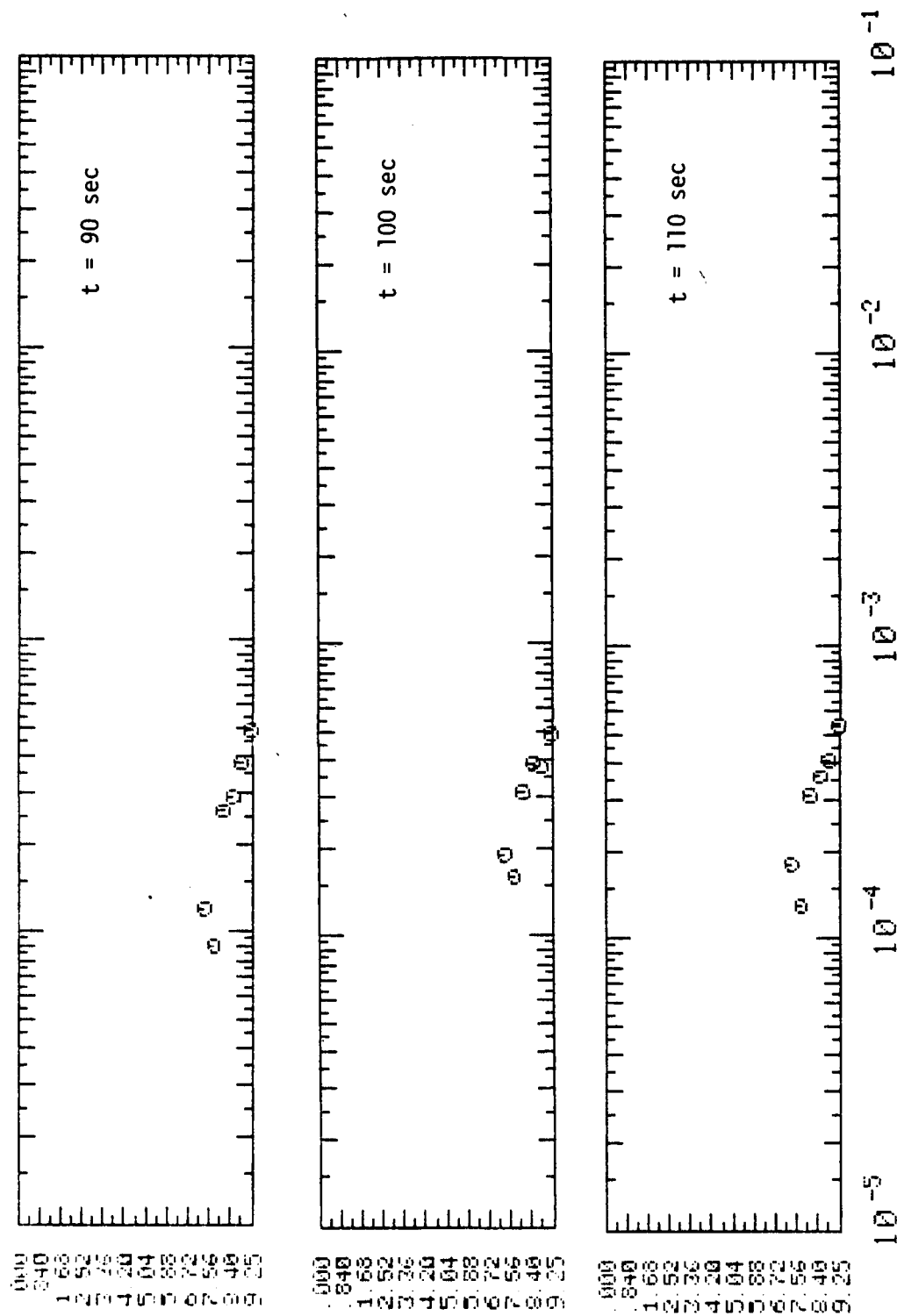
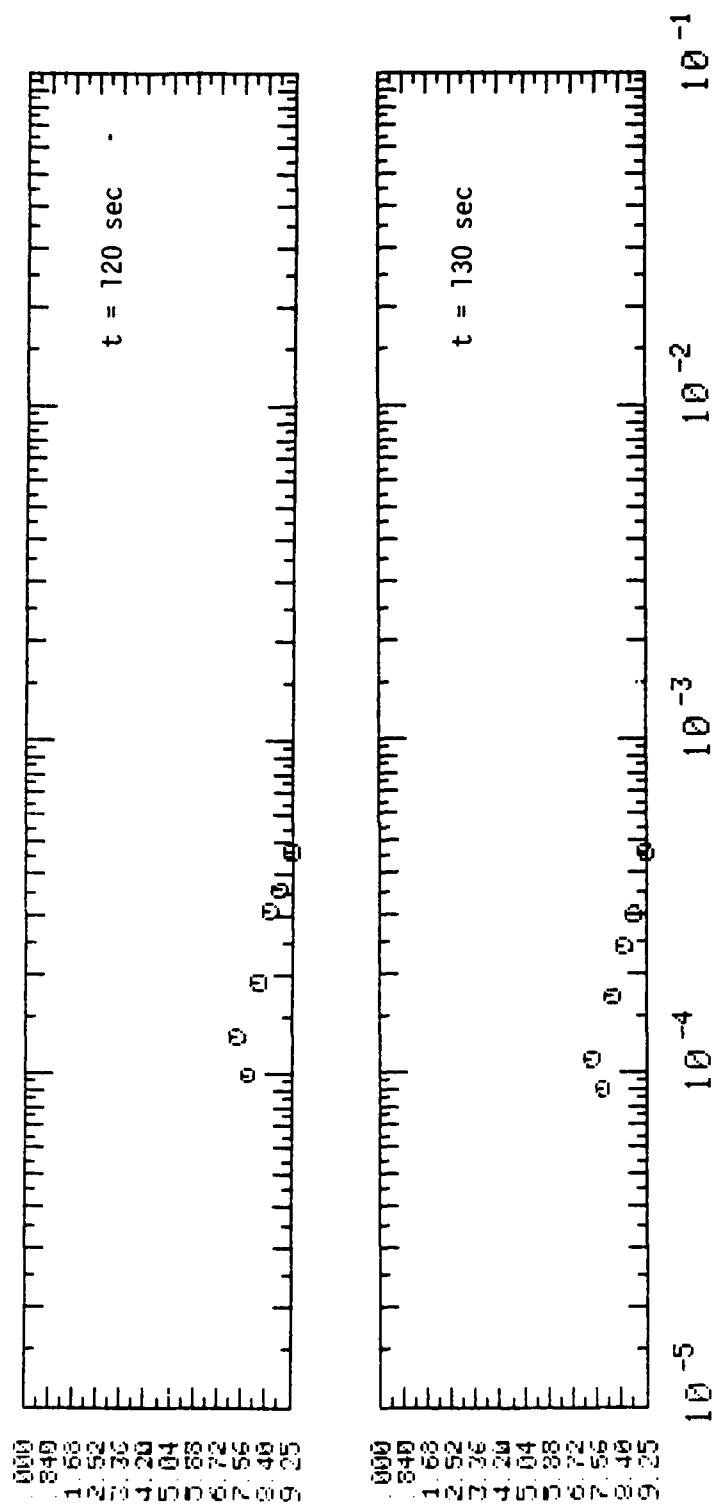
 C/C_0 , DIMENSIONLESS CONCENTRATION $X = 168$ IN., $Y = 0$ IN.

FIGURE C-13. RUN 11.1-7A VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE C-14. RUN II.1-7A VERTICAL CONCENTRATION PROFILES

APPENDIX D

CONCENTRATION PROFILES FOR RUN II.1-7B

$$\rho_c/\rho = 1.05 \text{ (Sucrose)}$$

$$r_i/d = 0.125$$

$$u_r/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to t=0 (Reference) for:

time history graph	31 sec.
cross stream profiles	31 sec.
vertical profiles	31 sec.

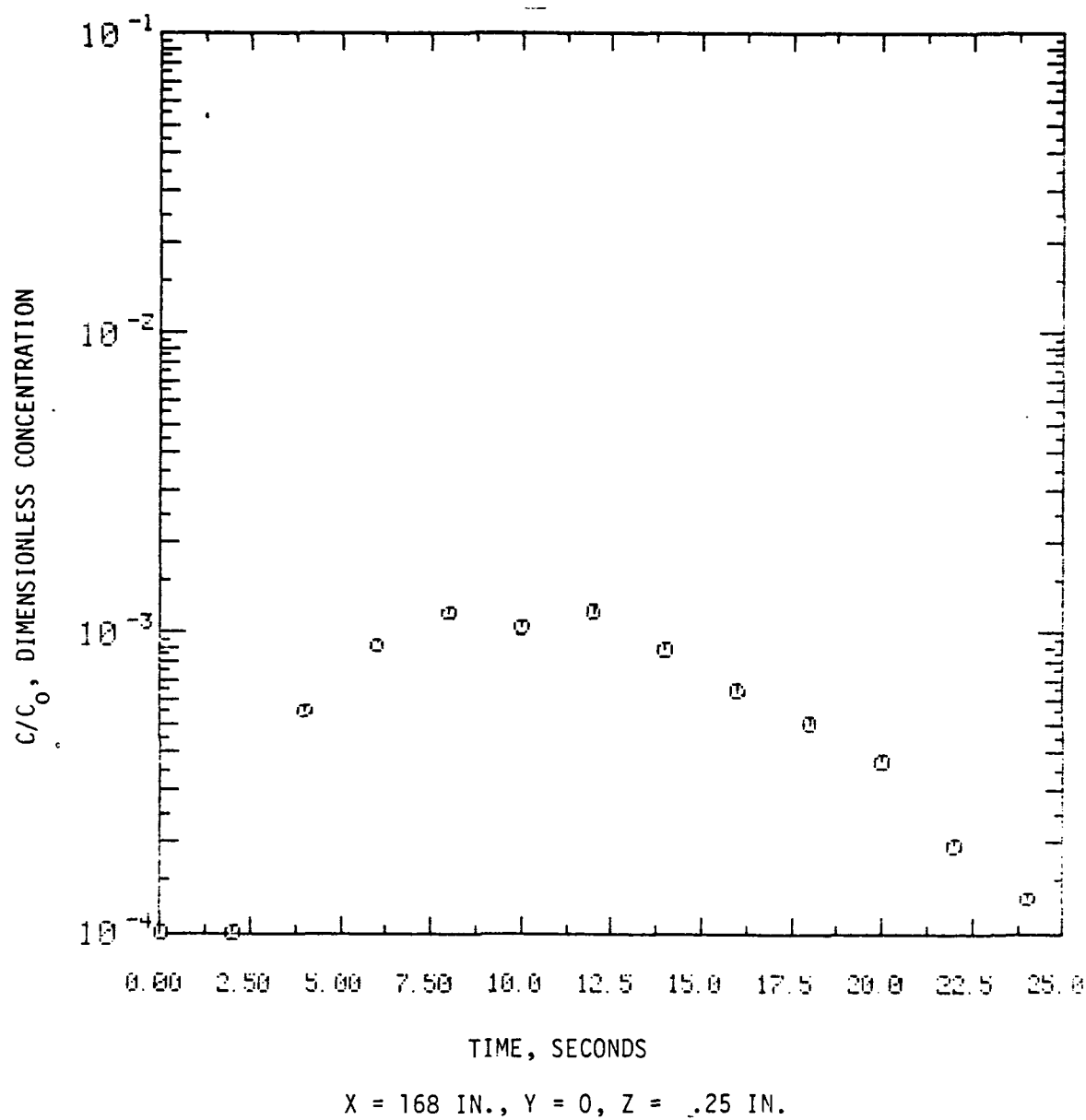


FIGURE D-1. RUN II.1-7B CONCENTRATION TIME HISTORY

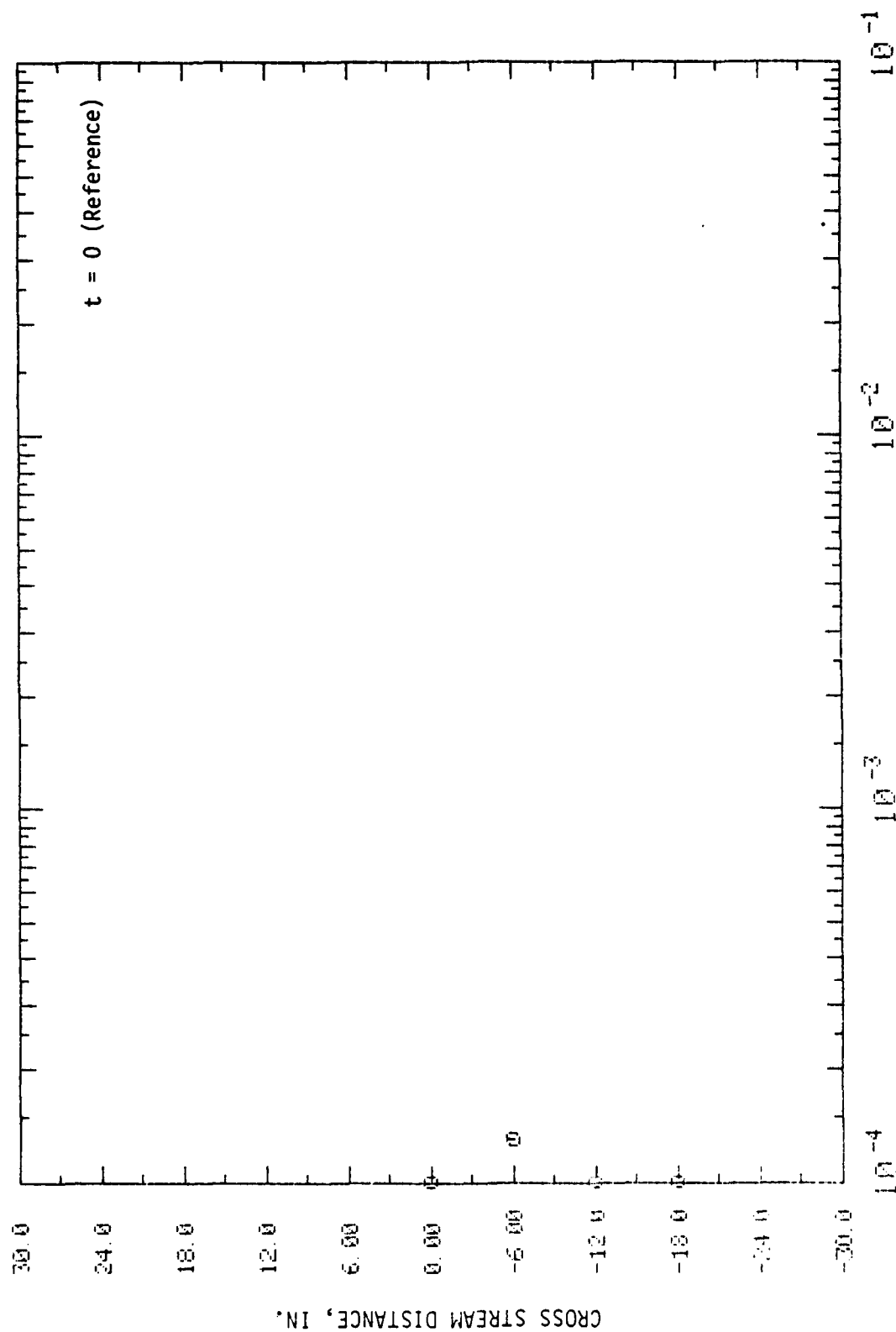


FIGURE D-2. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

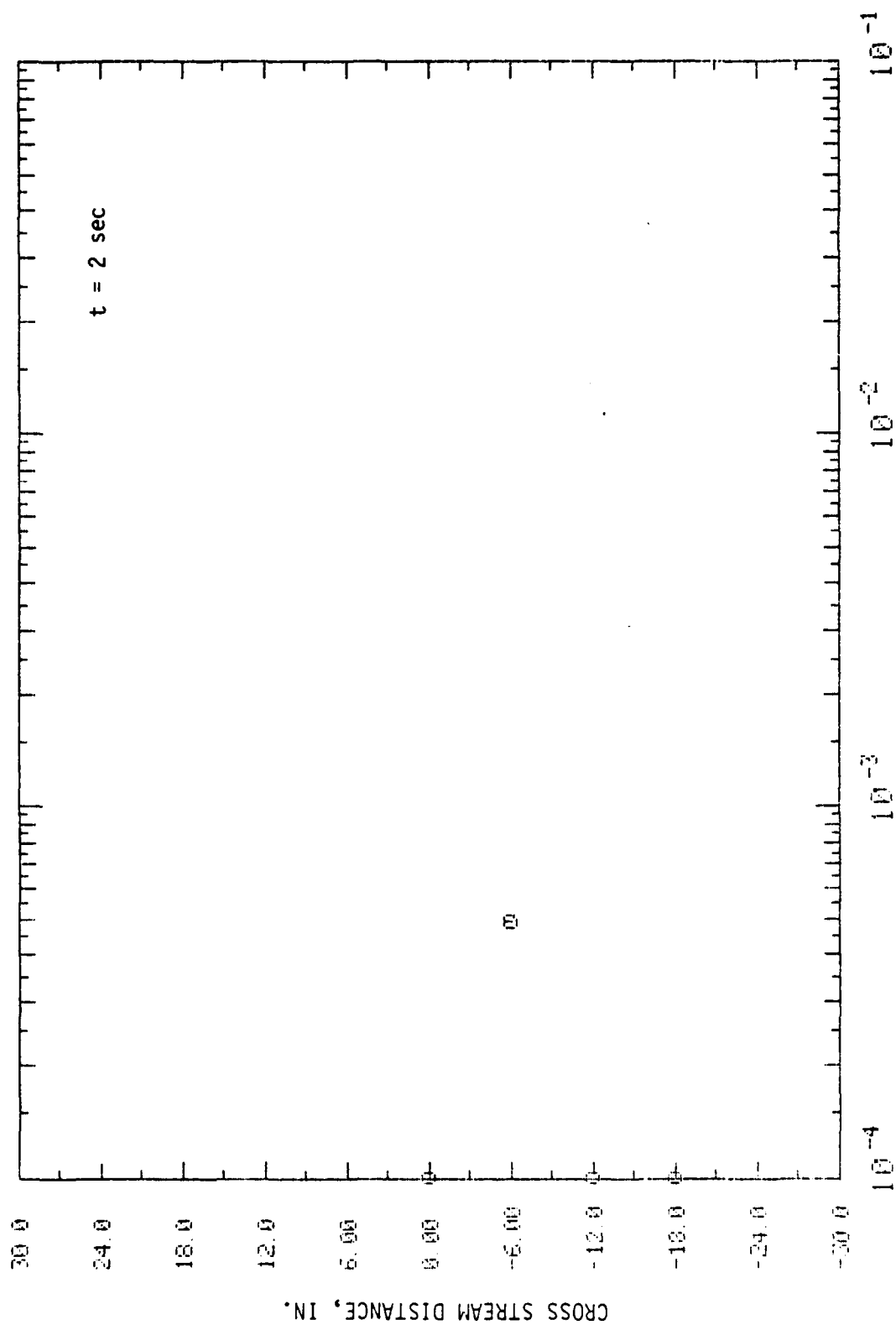


FIGURE D-3. RUN 11.1-7B CROSS STREAM CONCENTRATION PROFILE

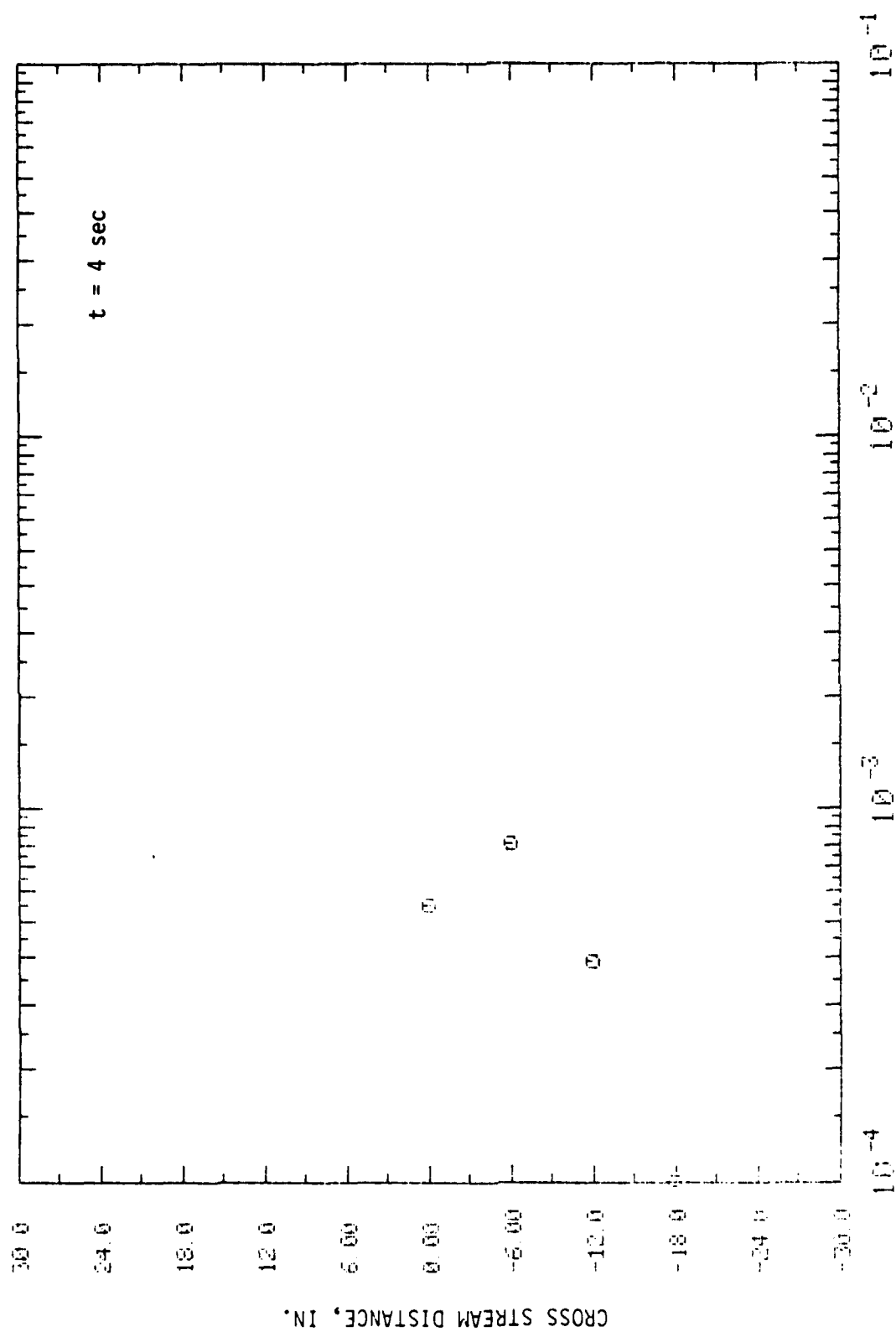


FIGURE D-4. RUN 11.1-7B CROSS STREAM CONCENTRATION PROFILE

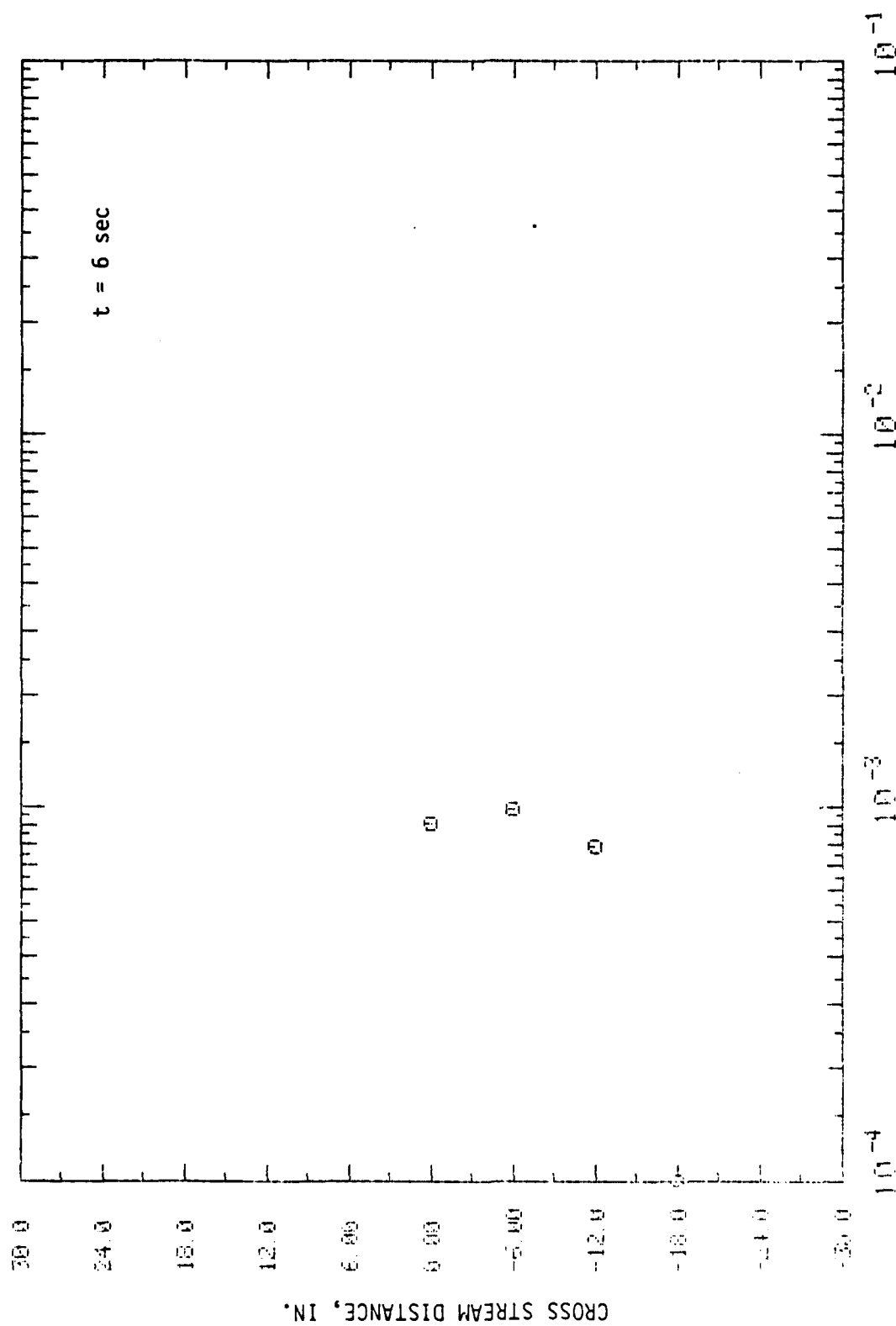
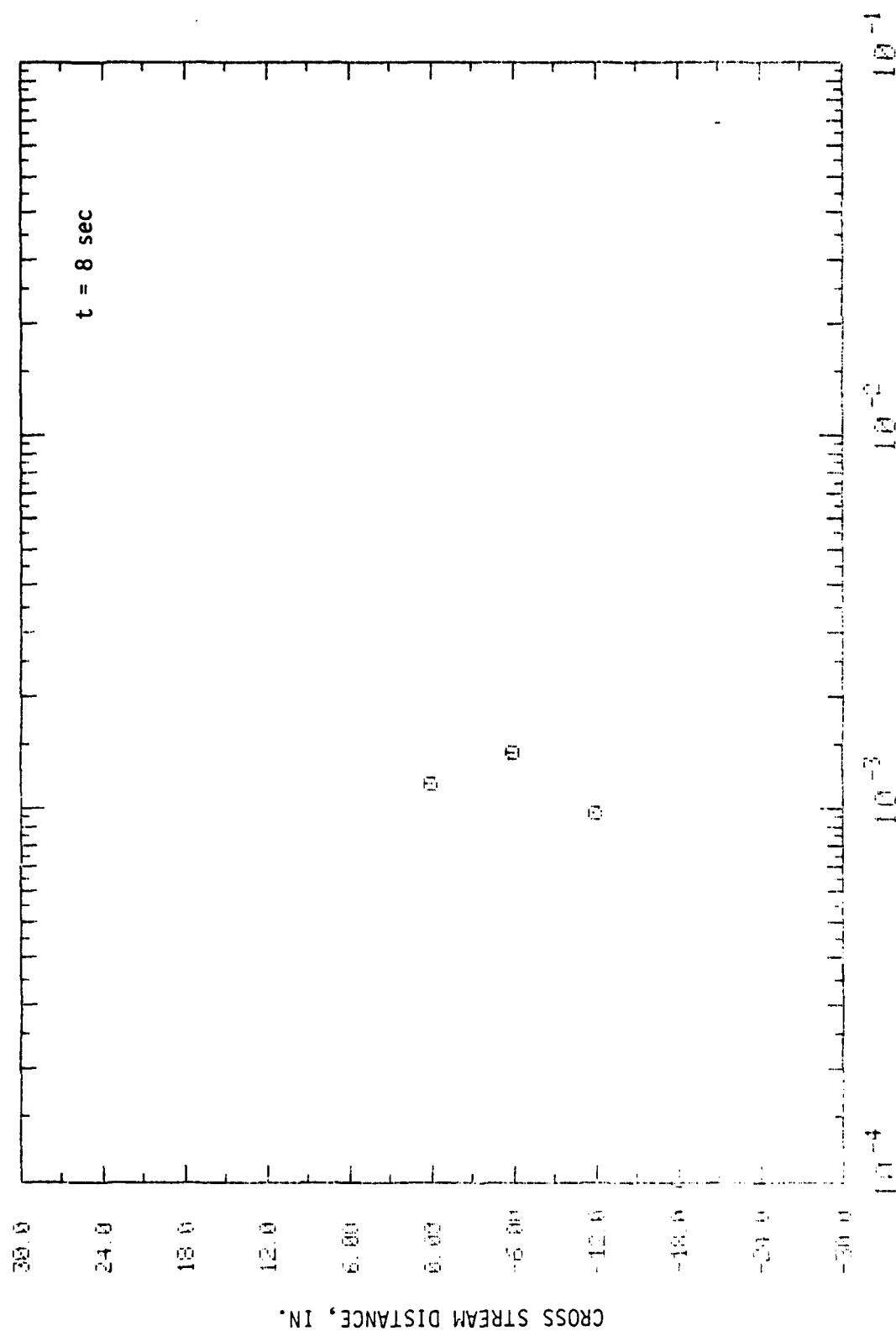


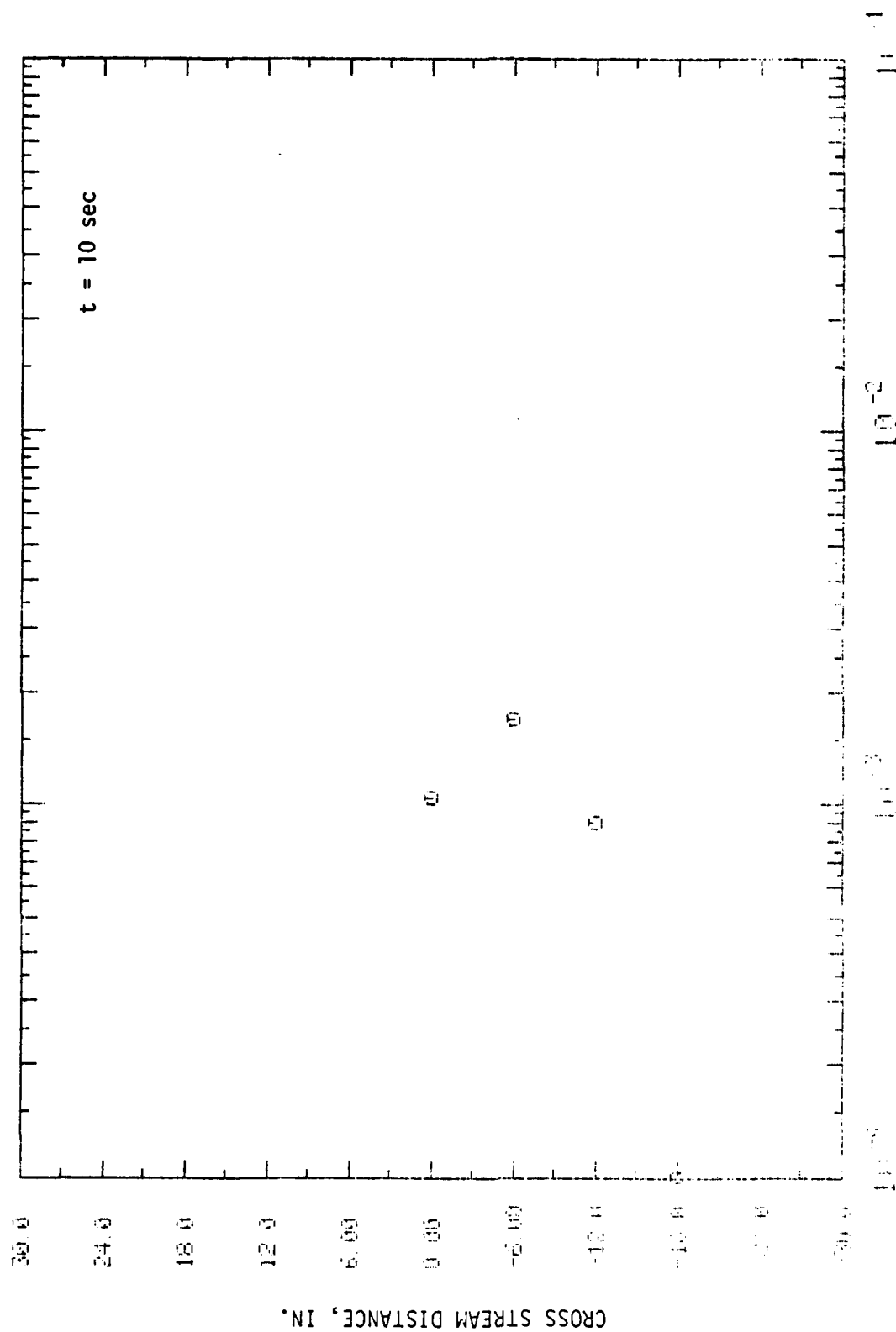
FIGURE D-5. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENS ONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE D-6 . RUN II.1.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE D-7. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

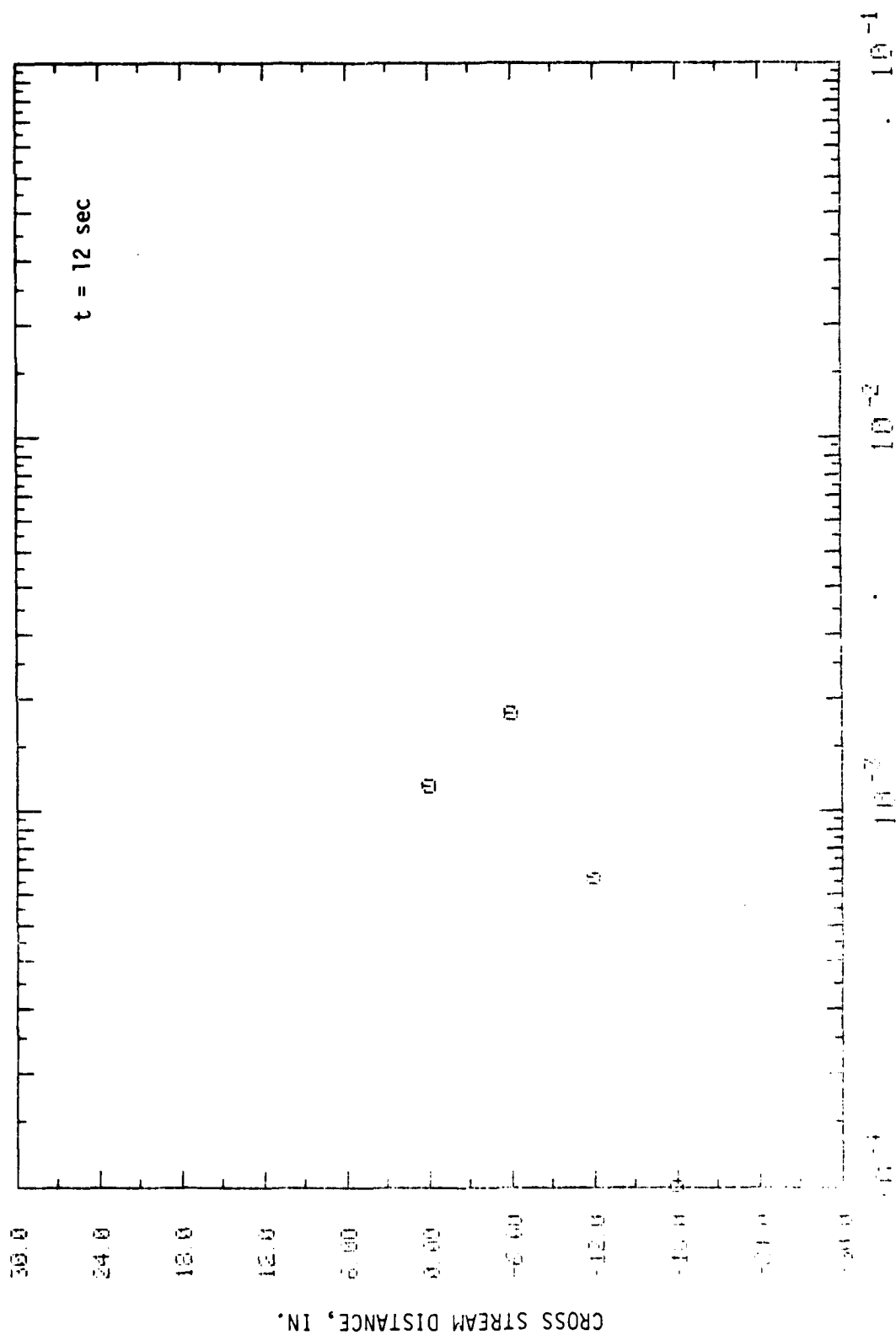
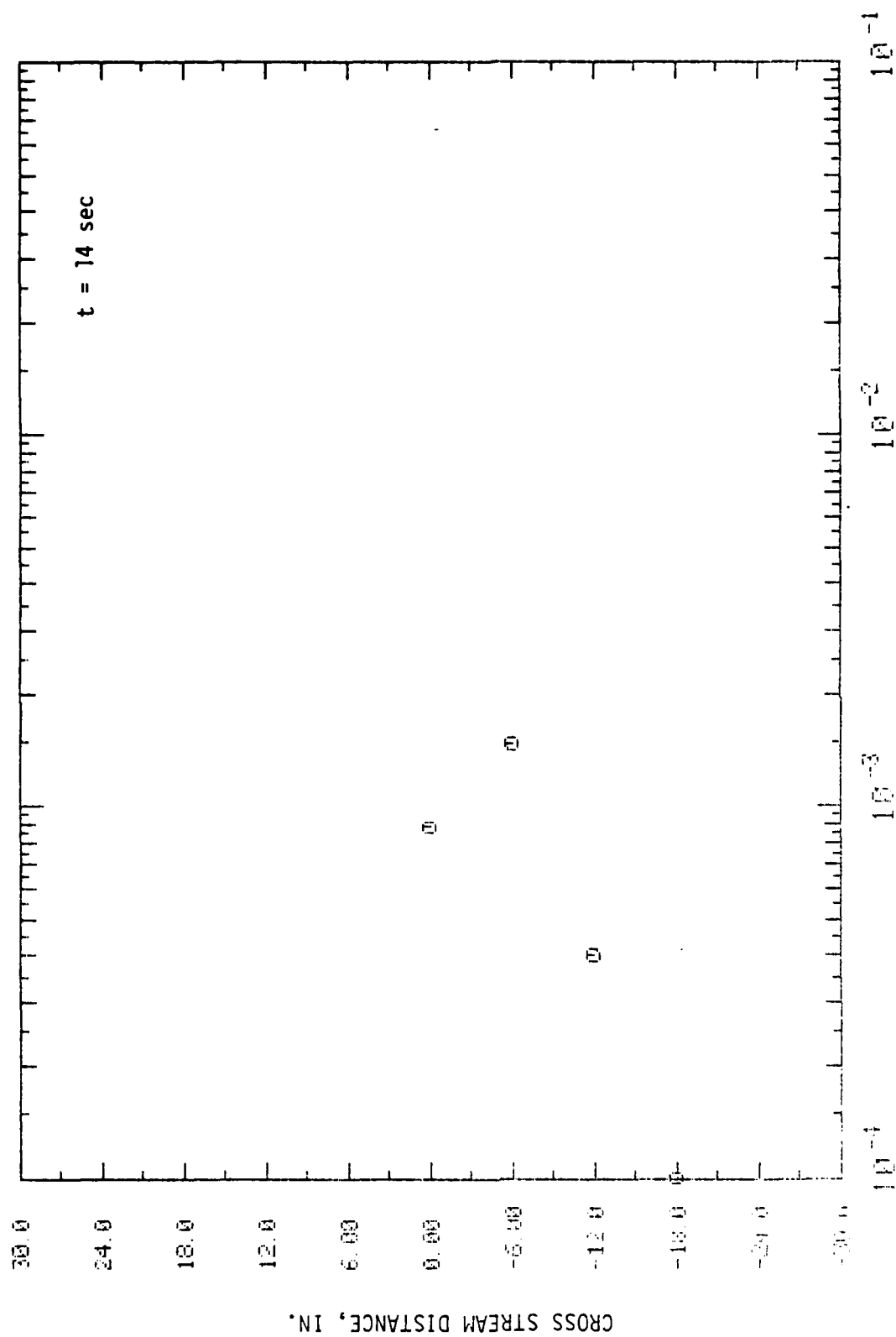


FIGURE D-8. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE D-9. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

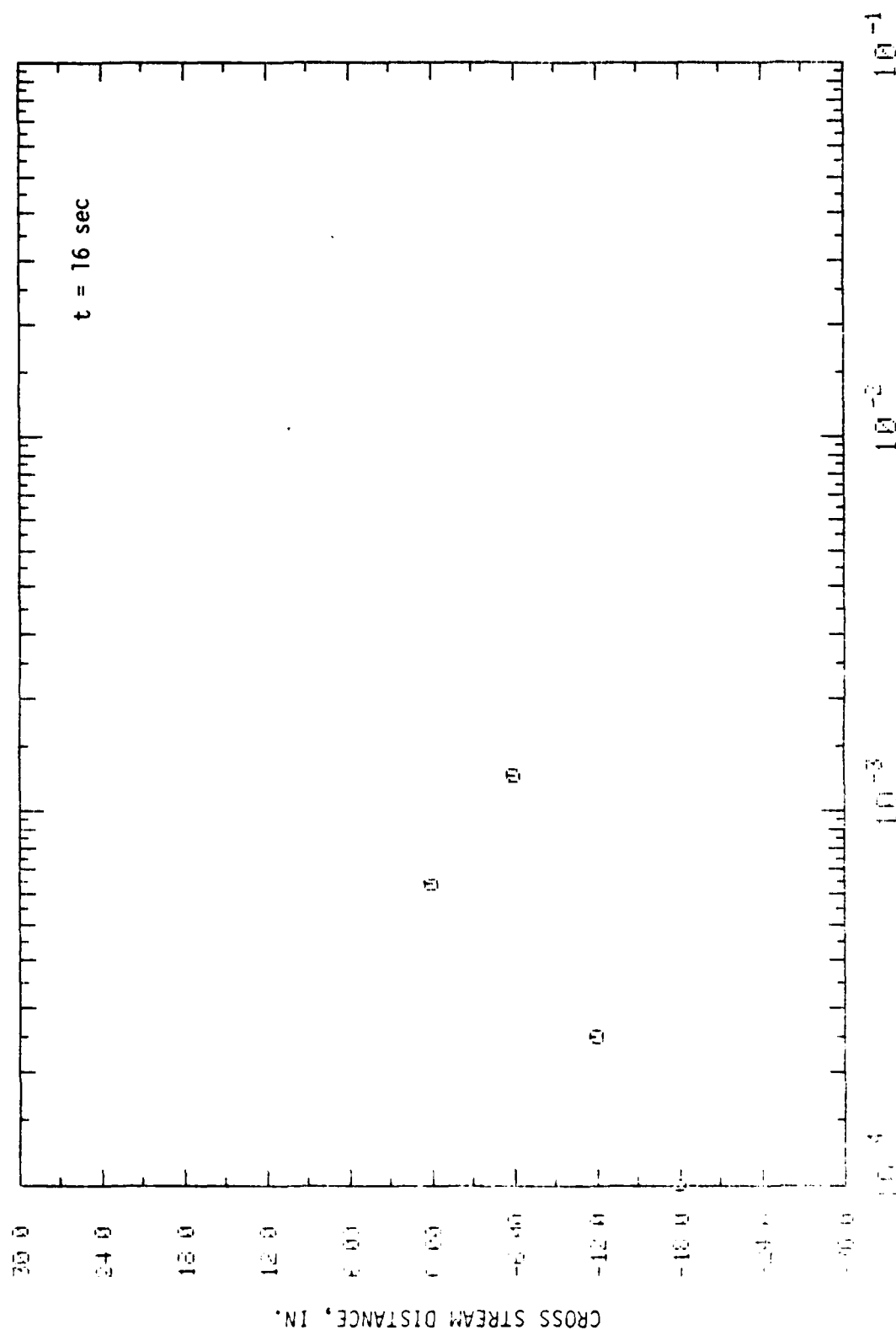
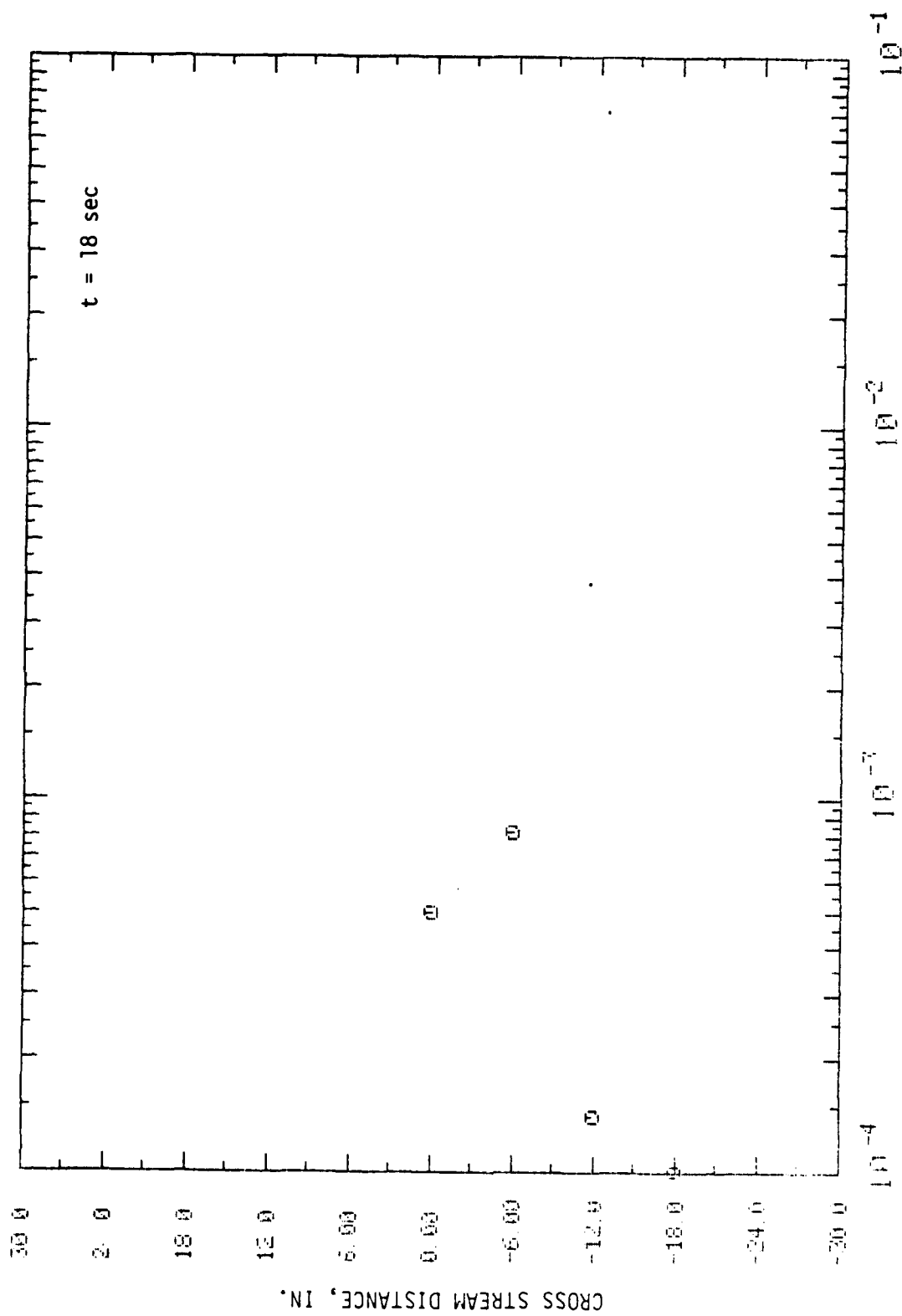


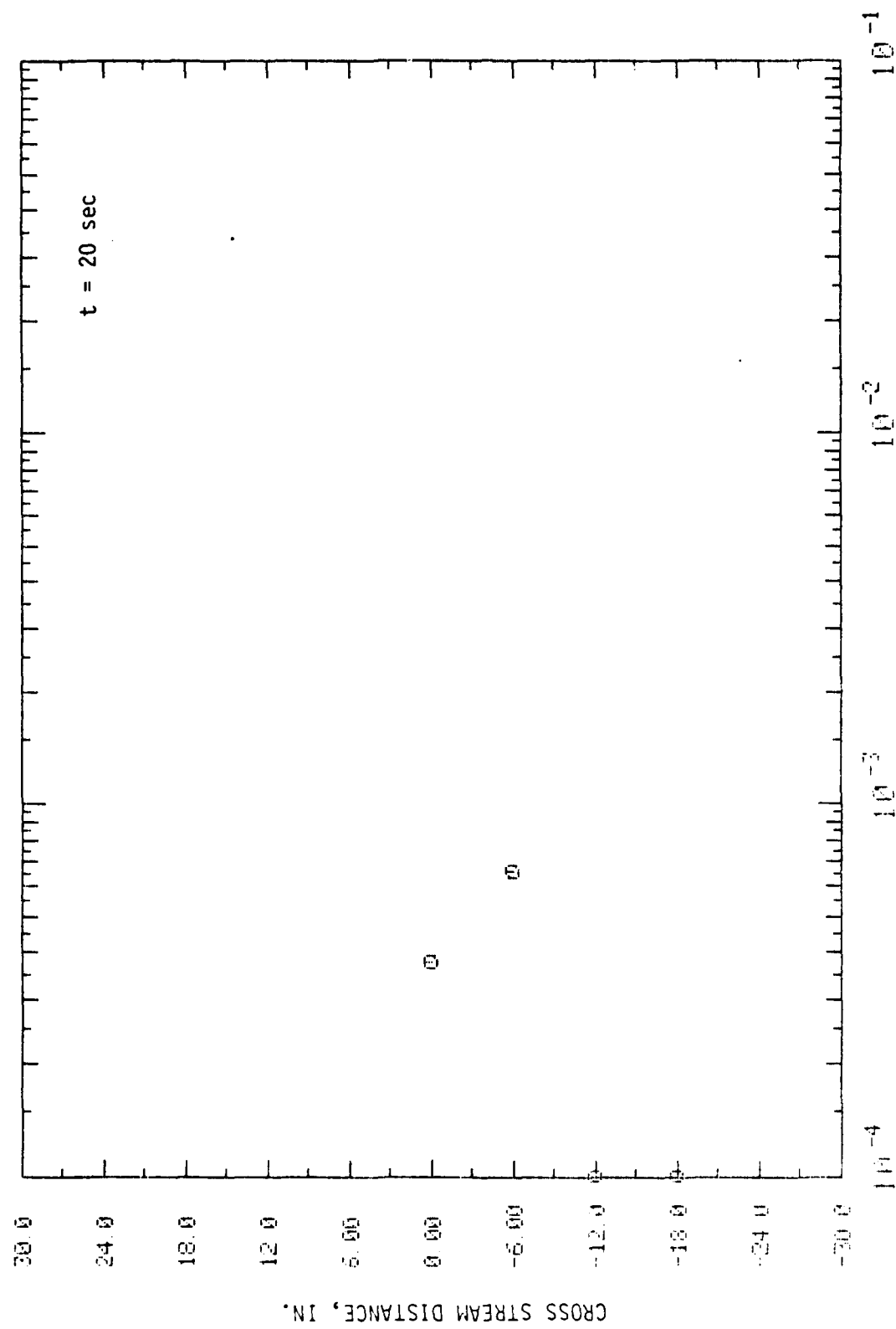
FIGURE D-10. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

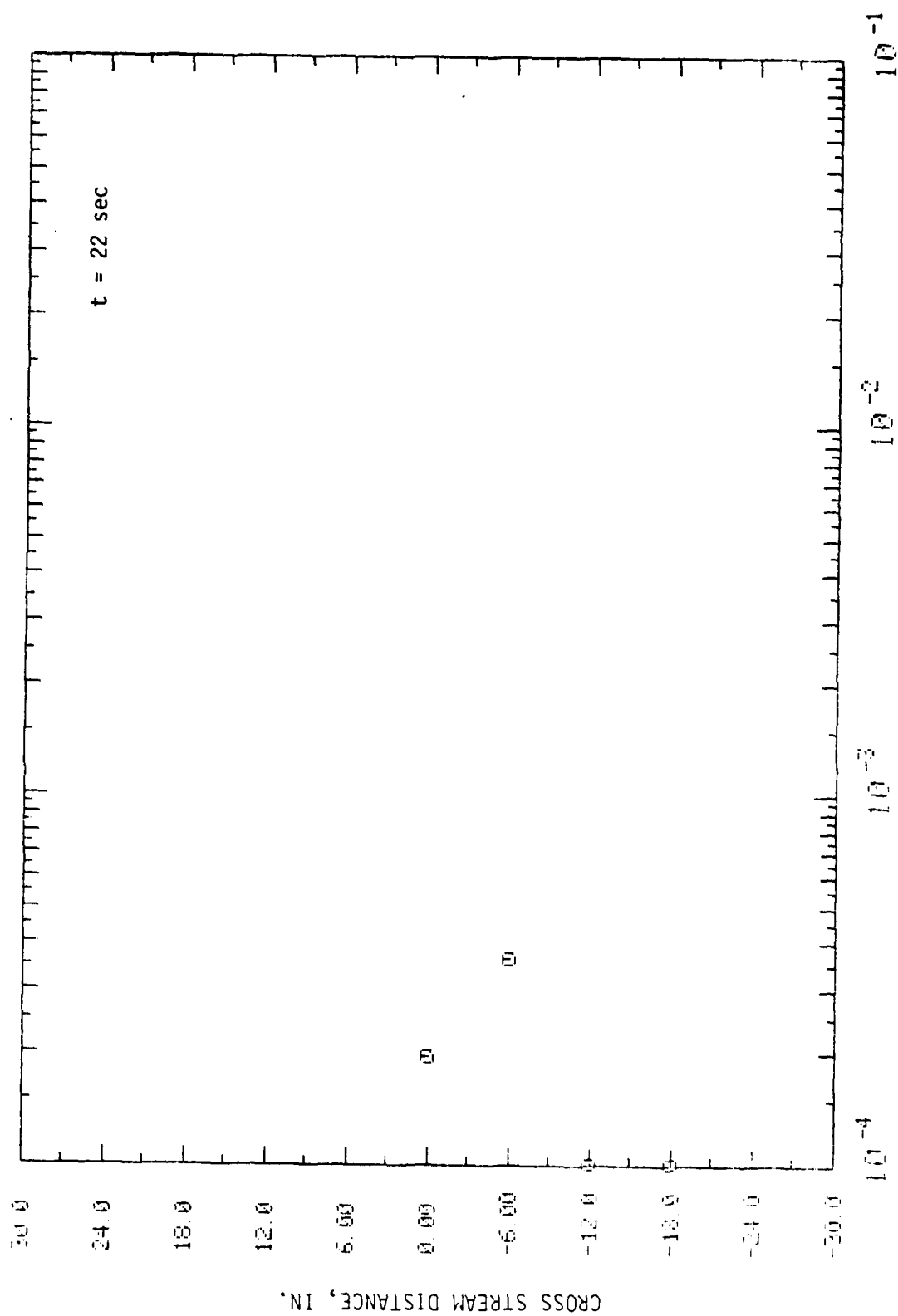
FIGURE D-11. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

FIGURE D-12. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

FIGURE D-13. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

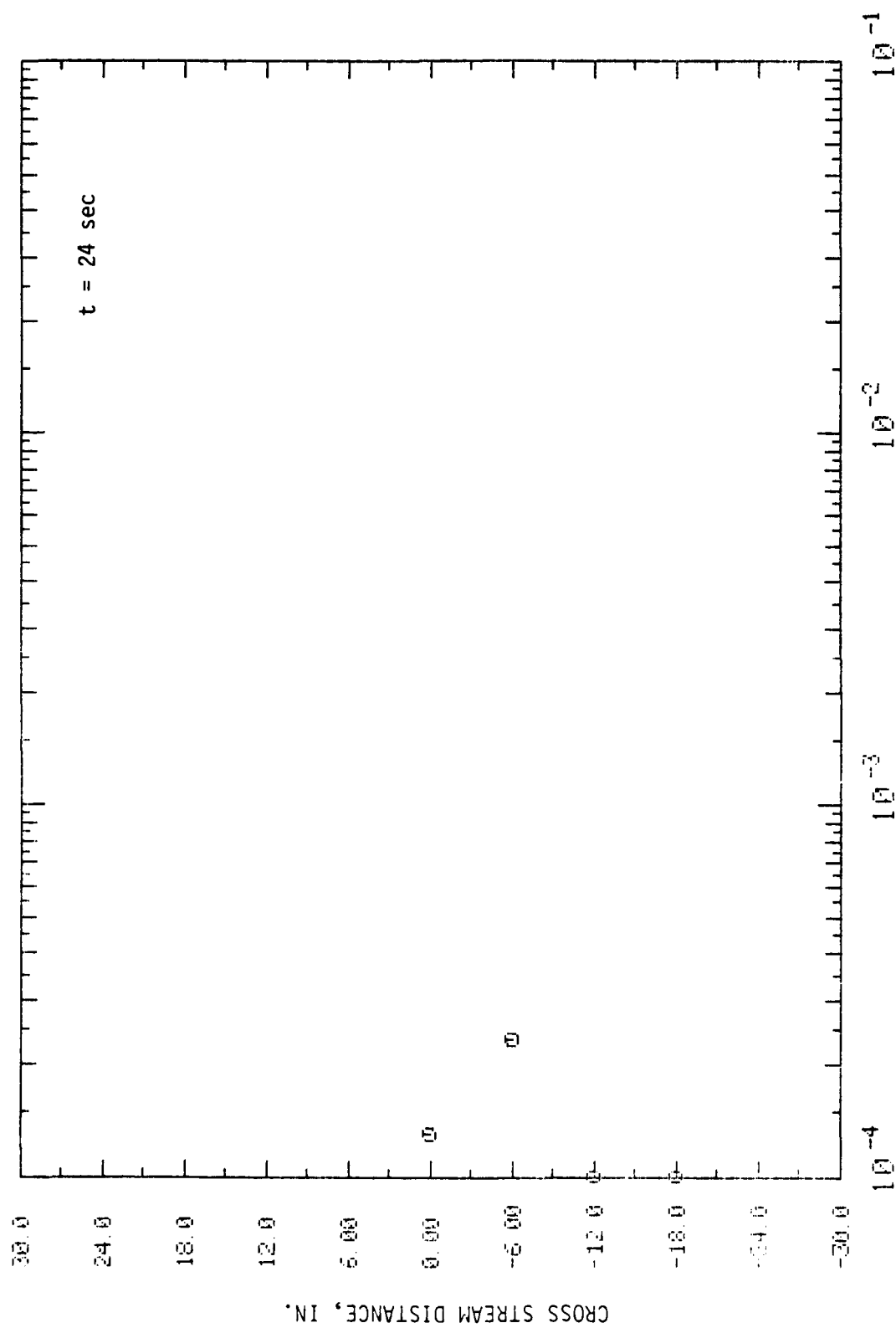


FIGURE D-14 . RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

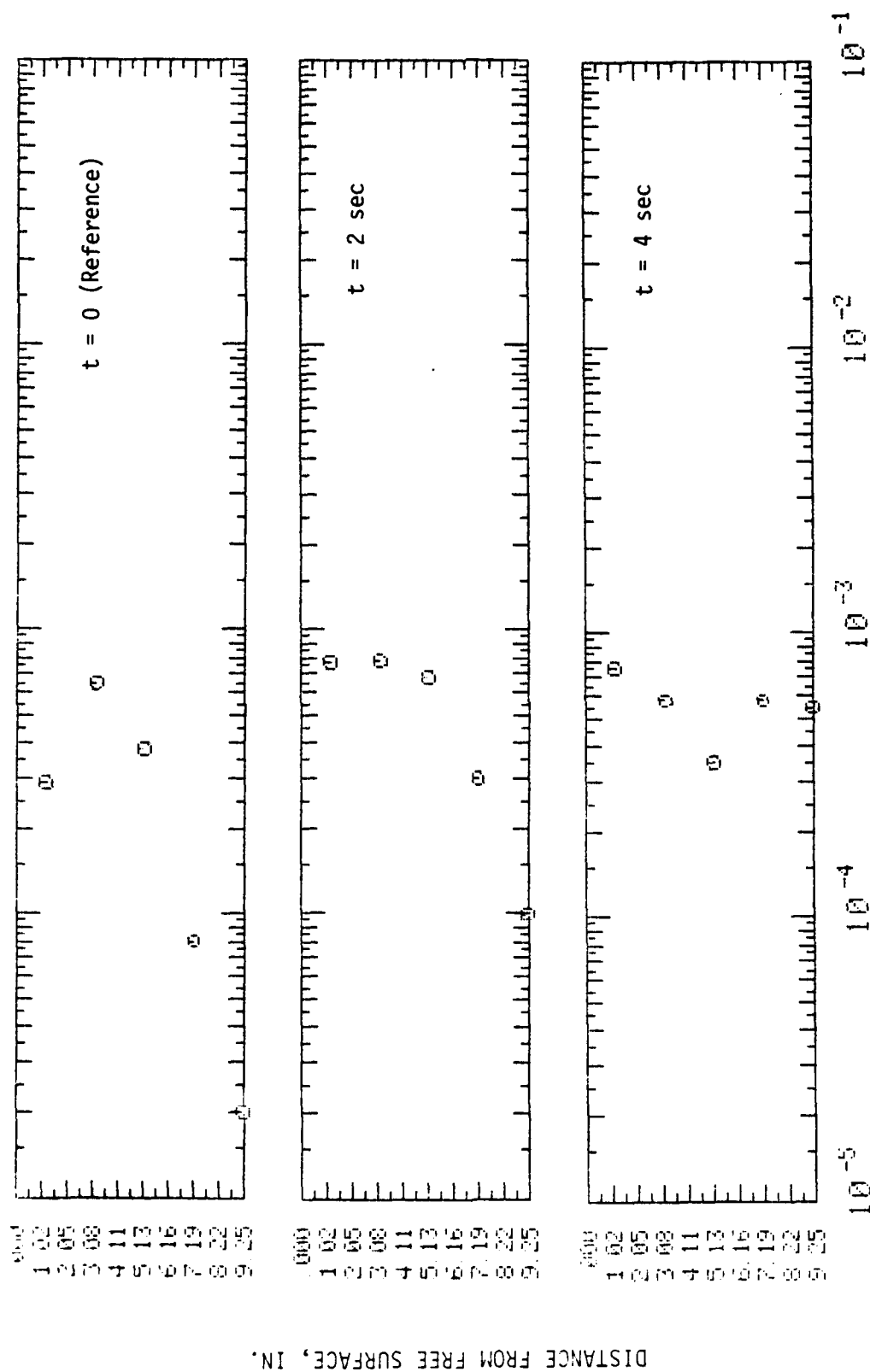
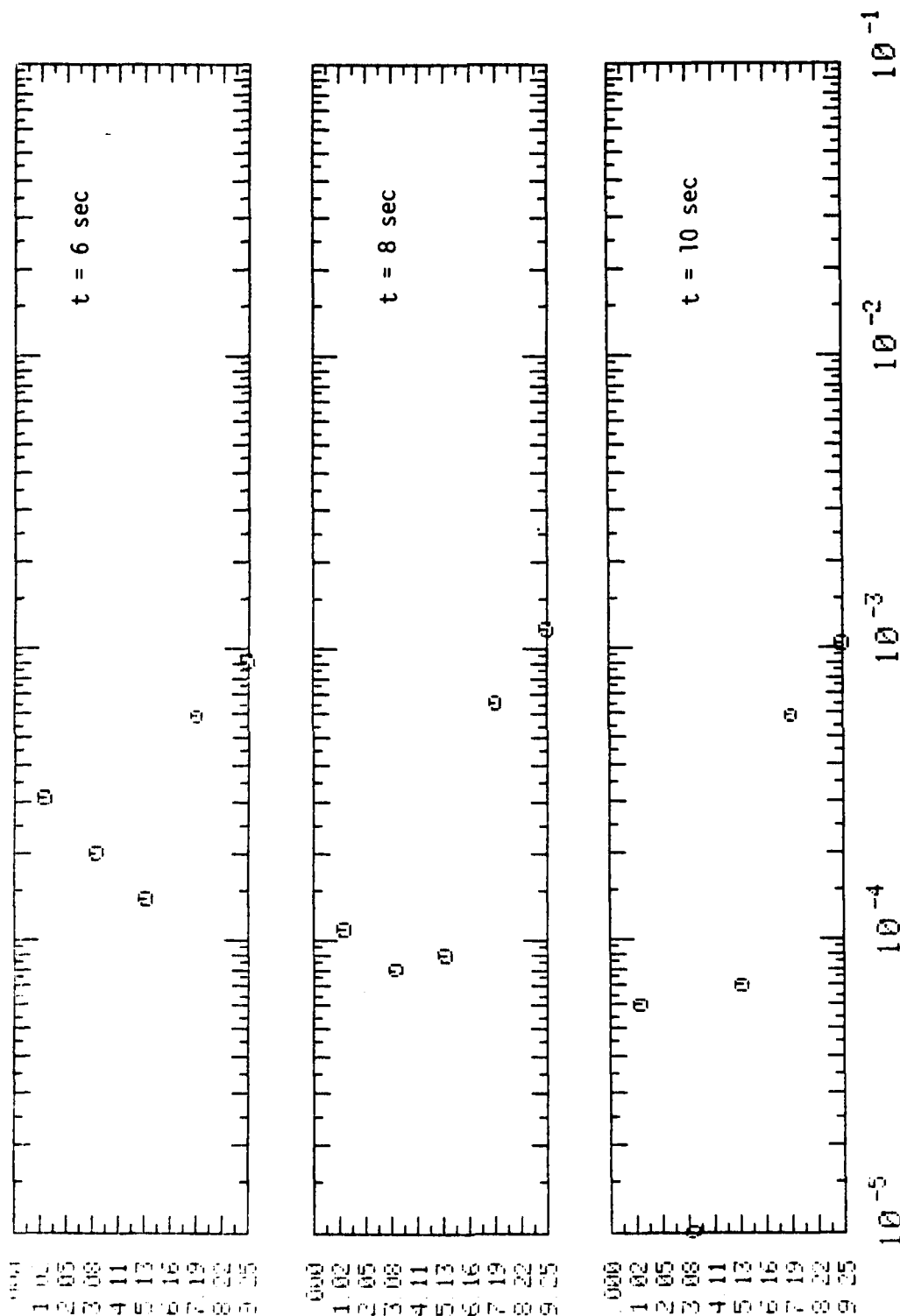


FIGURE D-15. RUN II.1-7B VERTICAL CONCENTRATION PROFILES

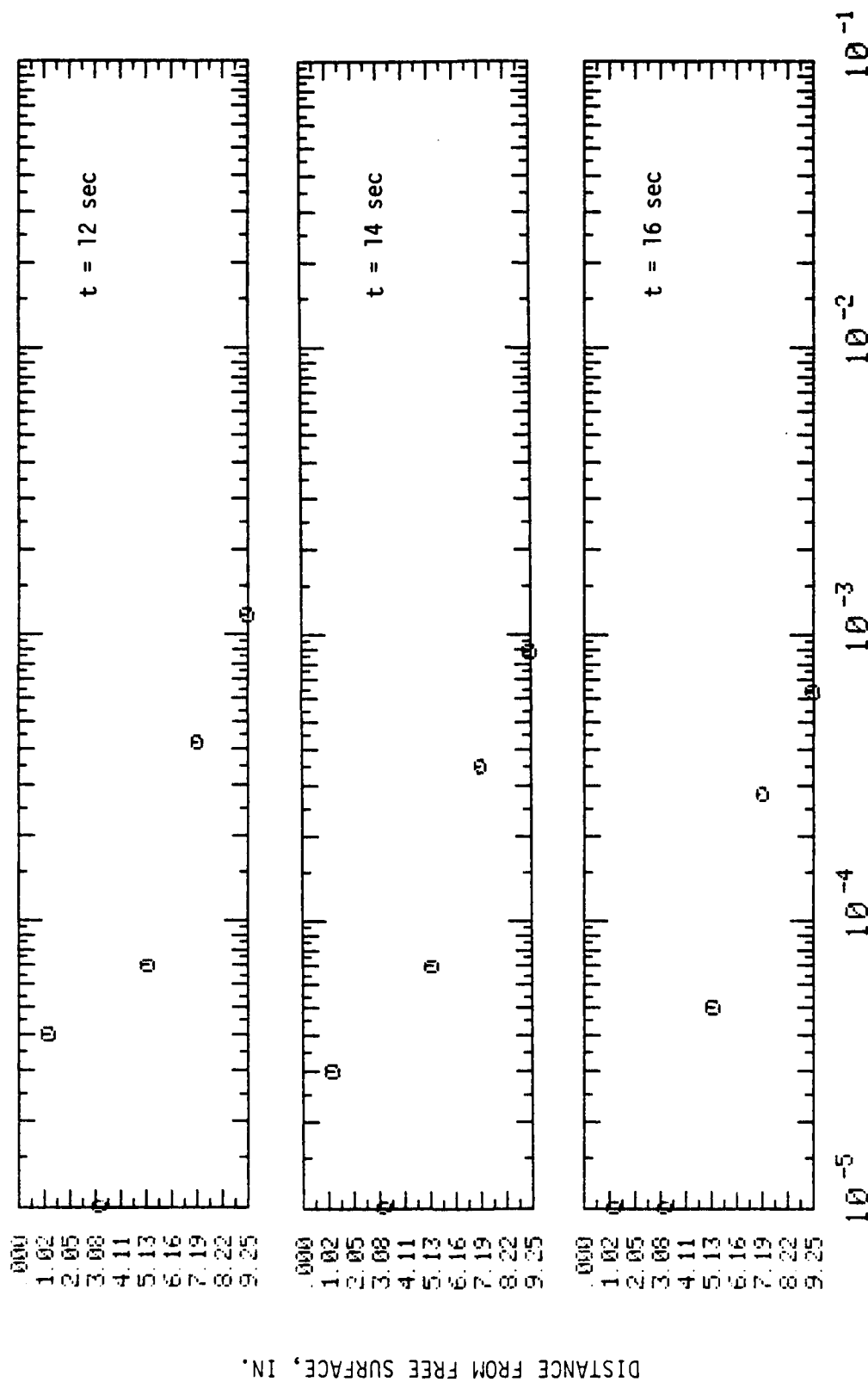
DISTANCE FROM FREE SURFACE, IN.



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE D-16. RUN II.1-7B VERTICAL CONCENTRATION PROFILES



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

FIGURE D-17. RUN II.1-7B VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

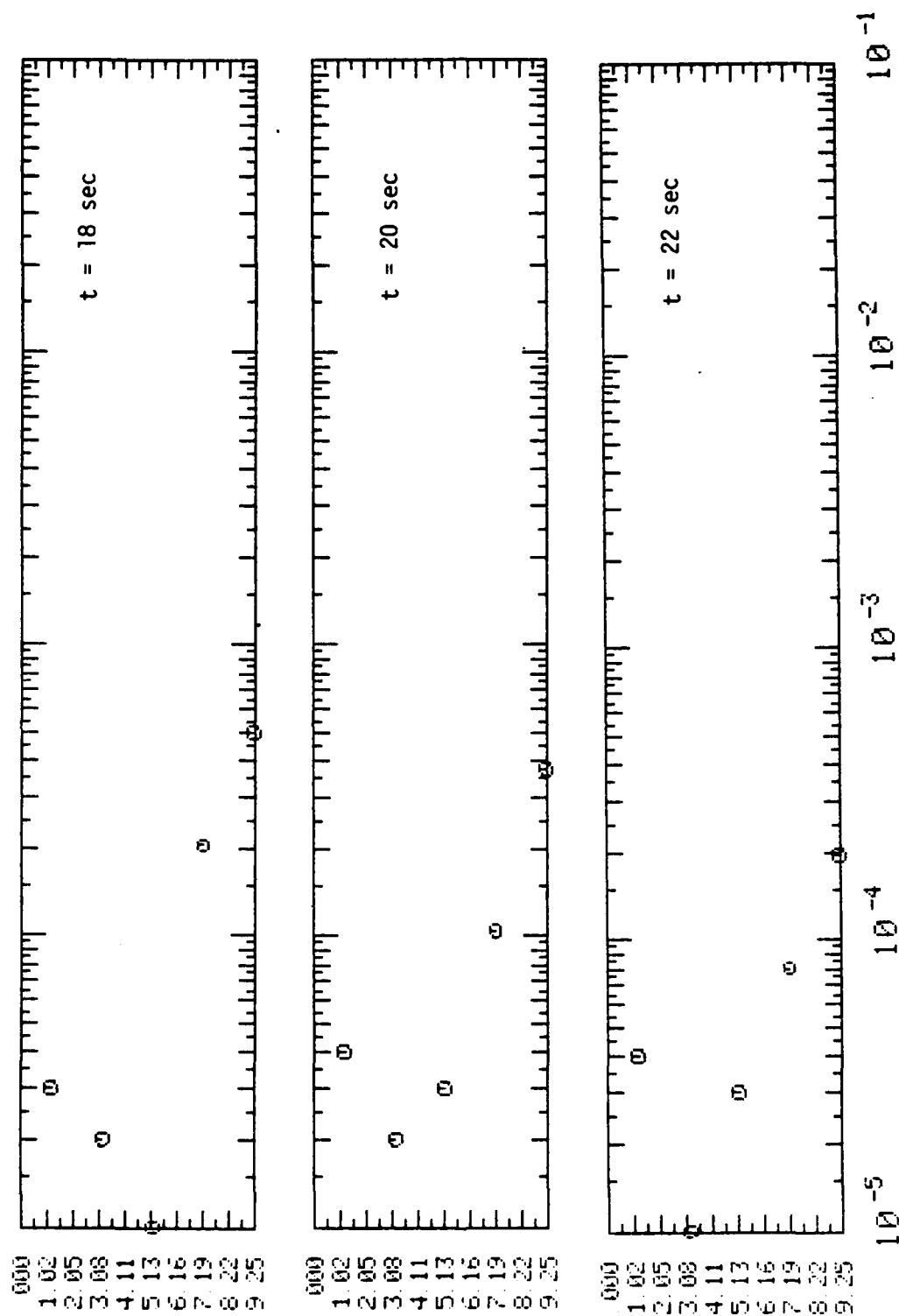
 C/C_0 , DIMENSIONLESS CONCENTRATION $X = 168$ IN., $Y = 0$ IN.

FIGURE D-18. RUN 11.1-7B VERTICAL CONCENTRATION PROFILES

APPENDIX E
CONCENTRATION PROFILES FOR
RUN II.1-8A

$$\rho_c/\rho = 1.05 \text{ (Sucrose)}$$

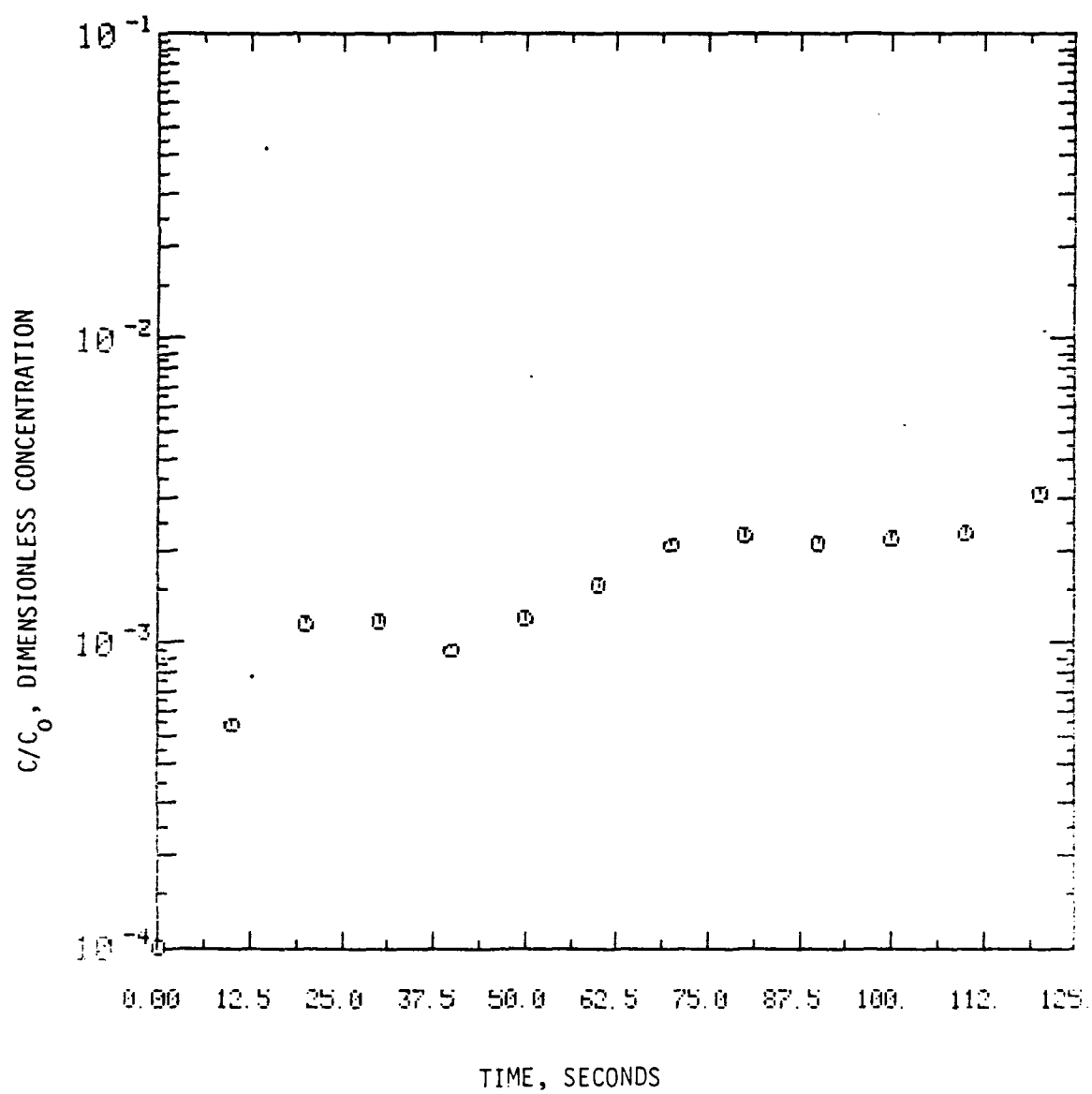
$$r_i/d = 0.23$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 3.5$$

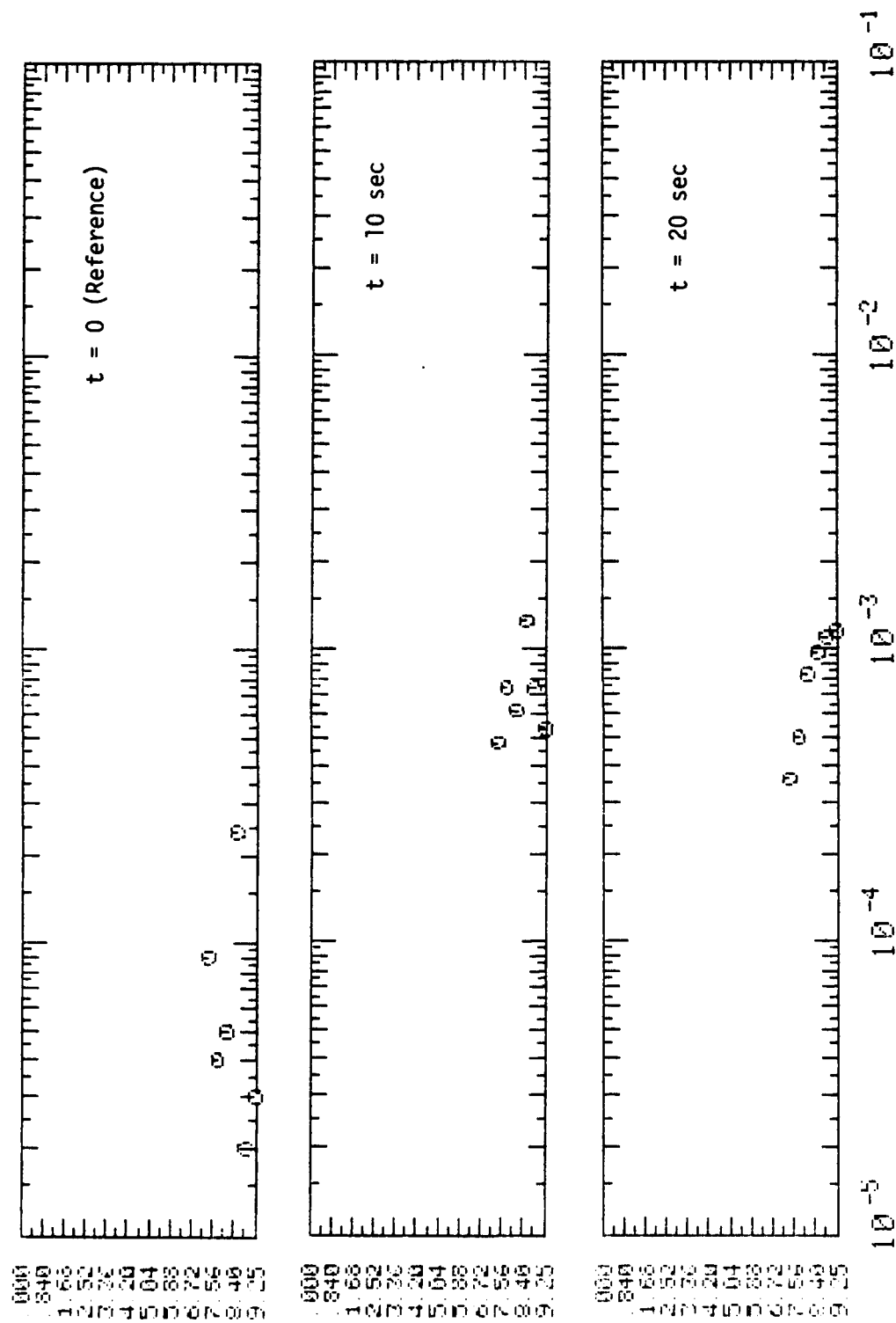
Time elapsed from spill to $t=0$ (Reference) for:

time history graph	97 sec.
vertical profiles	97 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

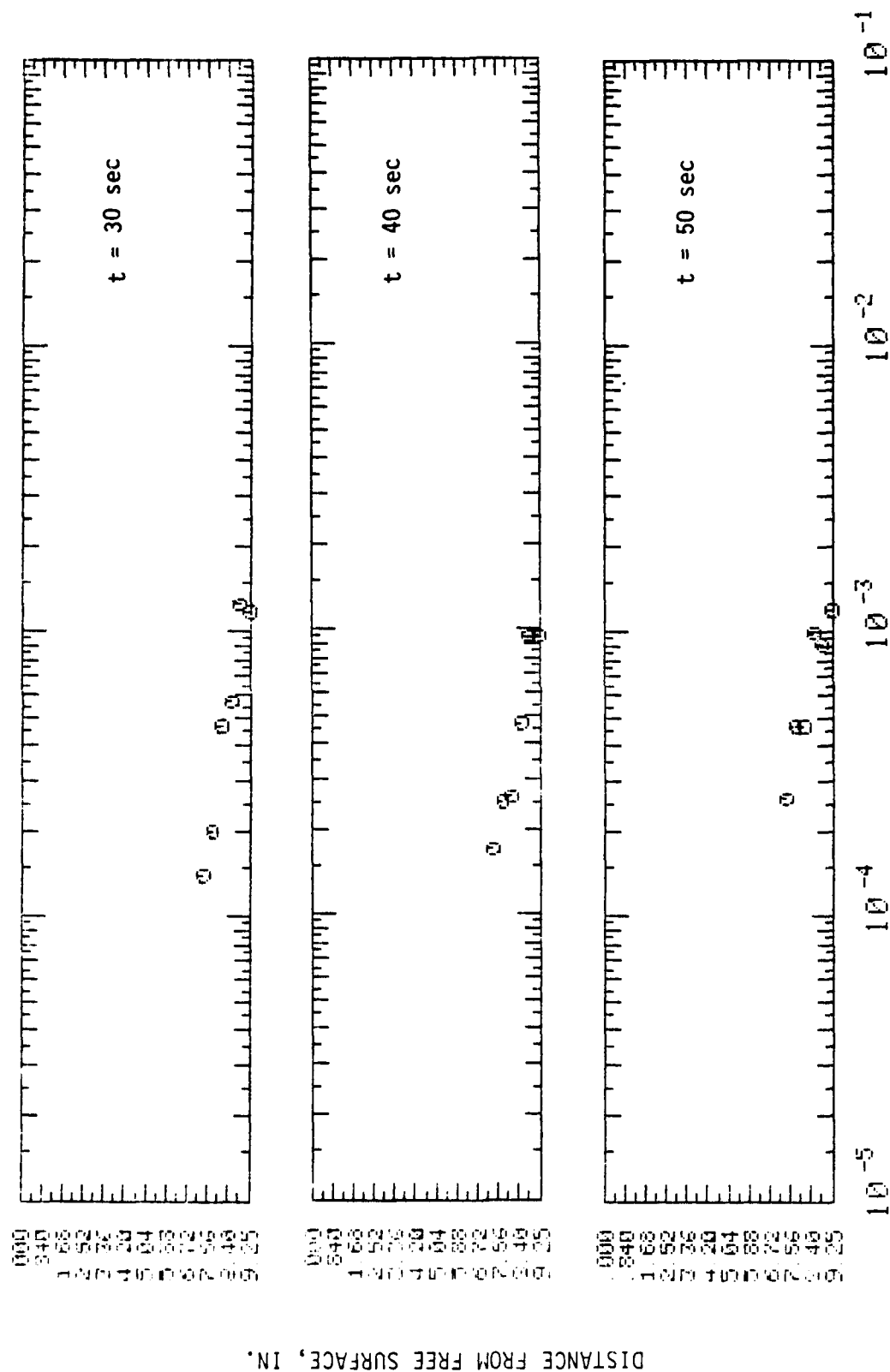
FIGURE E-1. RUN II.1-8A CONCENTRATION TIME HISTORY



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

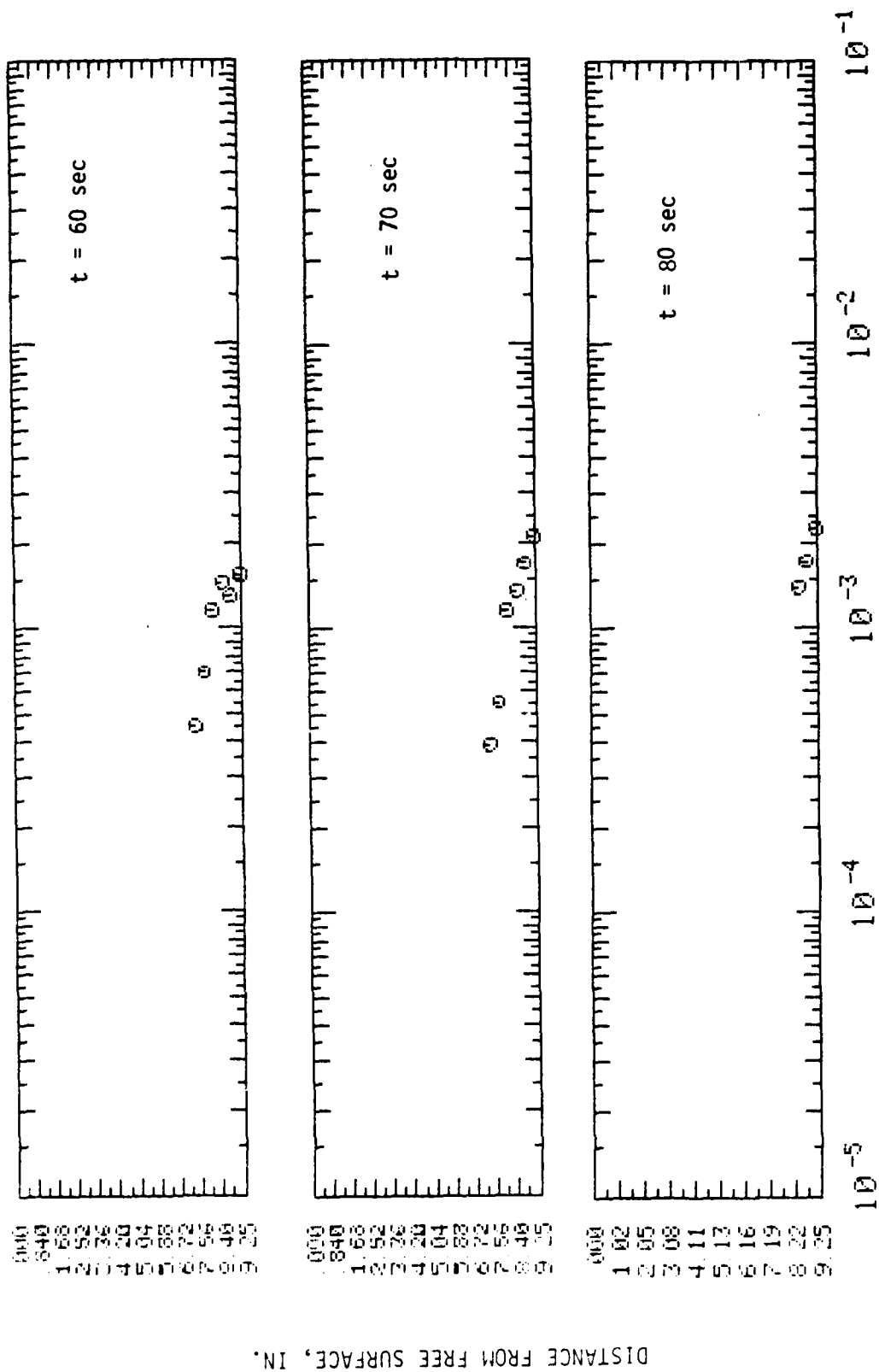
FIGURE E-2. RUN II.1-8A VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

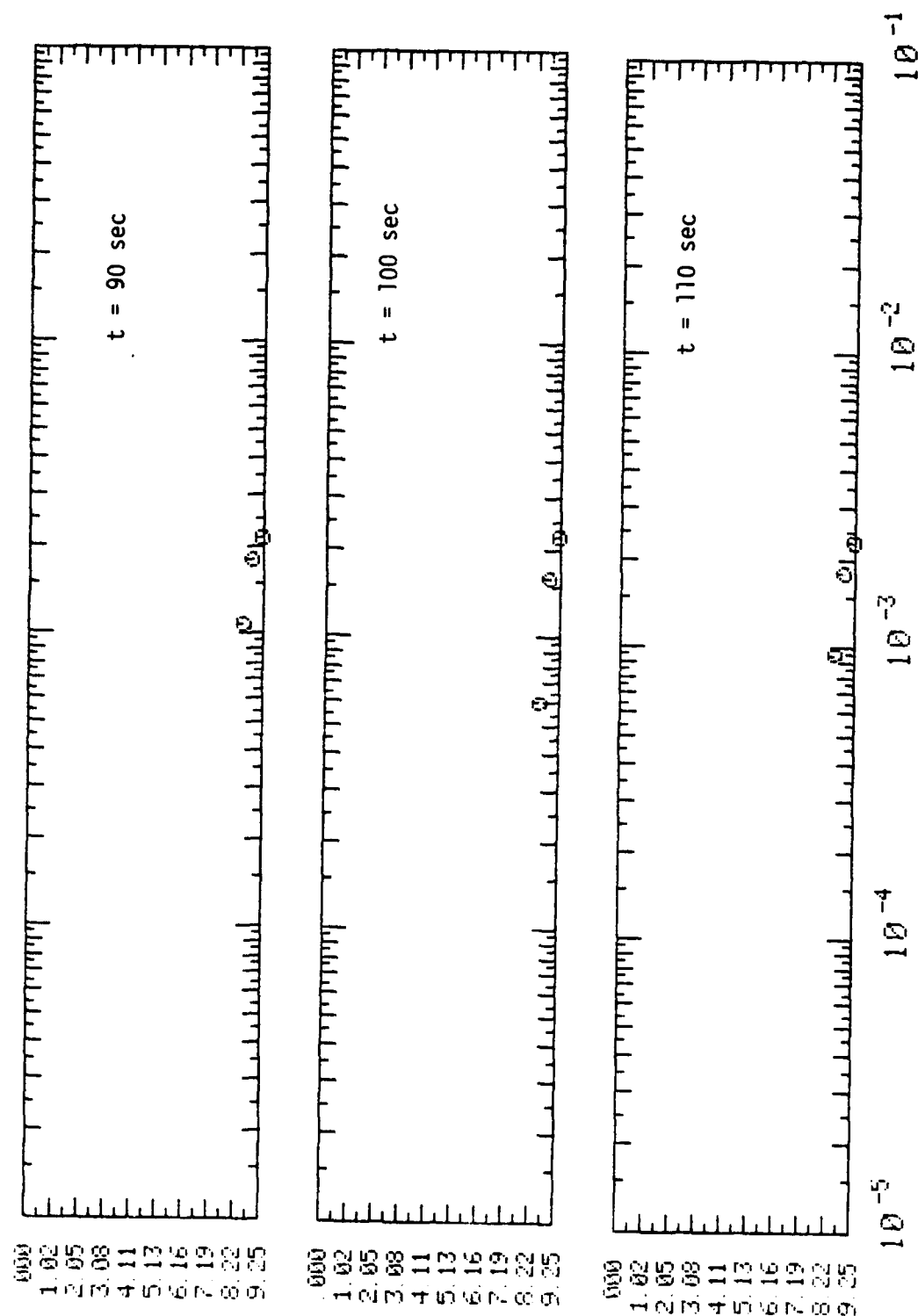
FIGURE E-3. RUN II.1-8A VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE E-4. RUN II.1-8A VERTICAL CONCENTRATION PROFILES



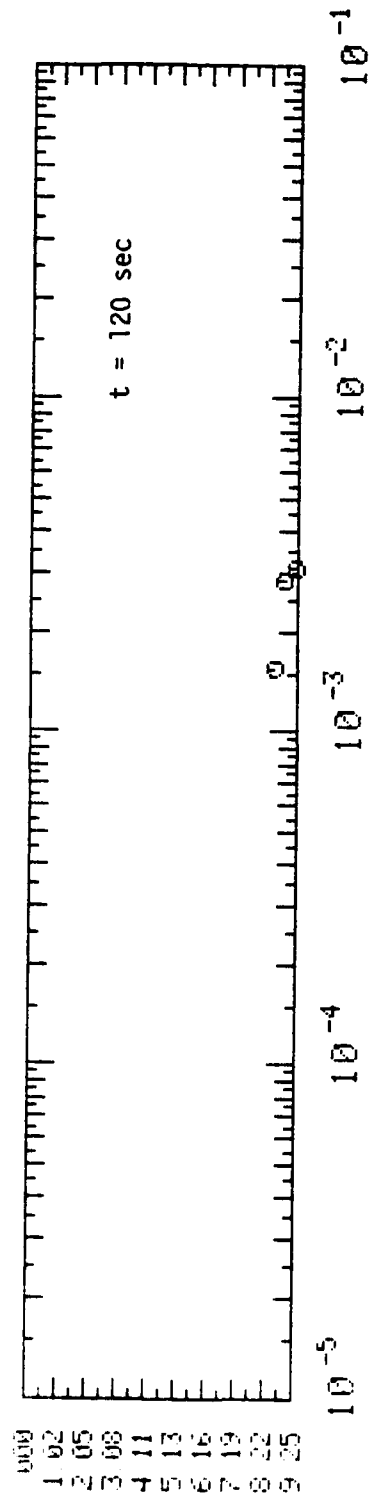
C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE E-5. RUN II.1.1-8A VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

E-6



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Y = 0 \text{ IN.}$

FIGURE E-6. RUN II.1.1-8A VERTICAL CONCENTRATION PROFILES

APPENDIX F

CONCENTRATION PROFILES FOR RUN II.1-8B

$$\rho_c/\rho = 1.05 \text{ (Sucrose)}$$

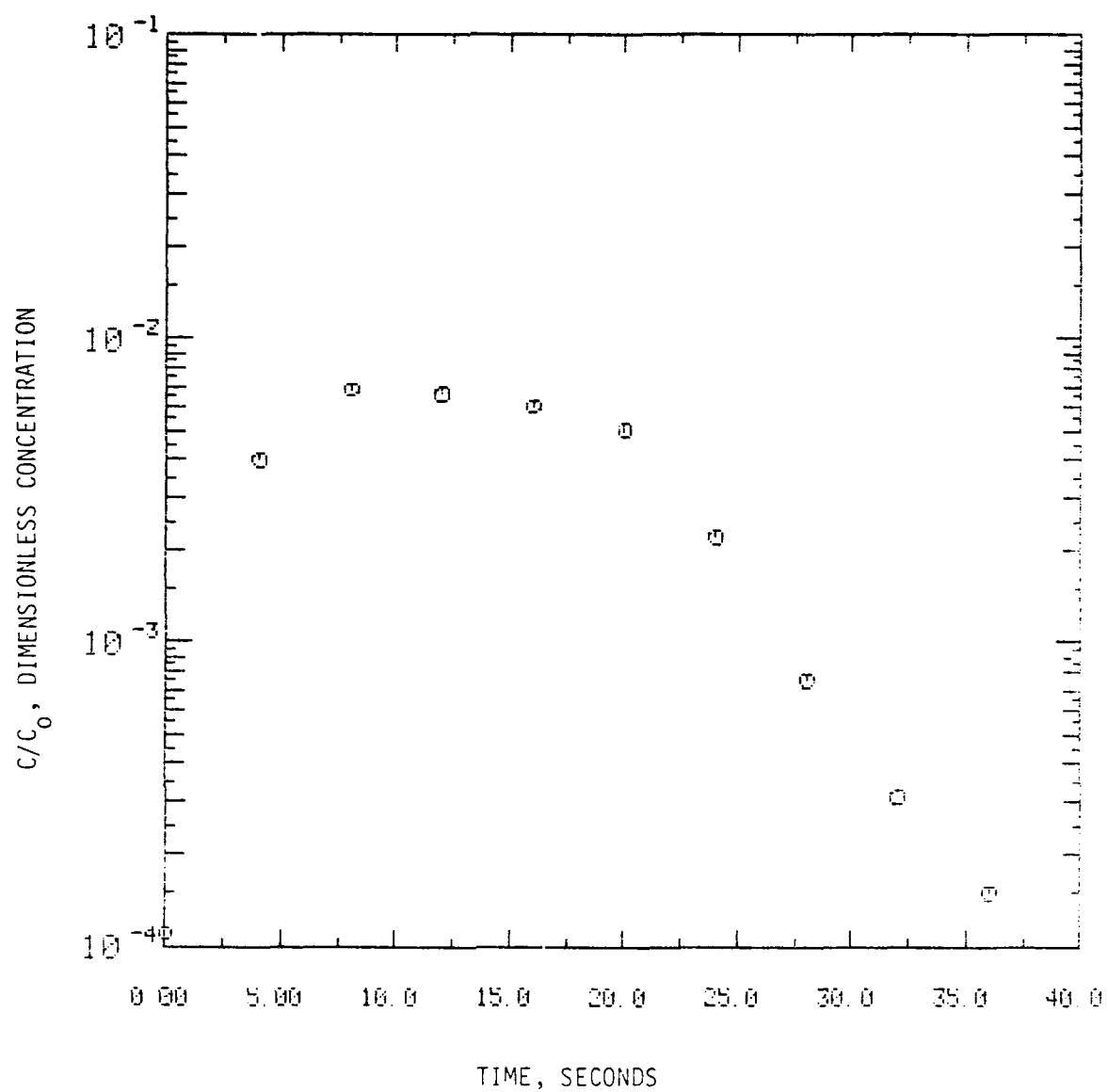
$$r_i/d = 0.23$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

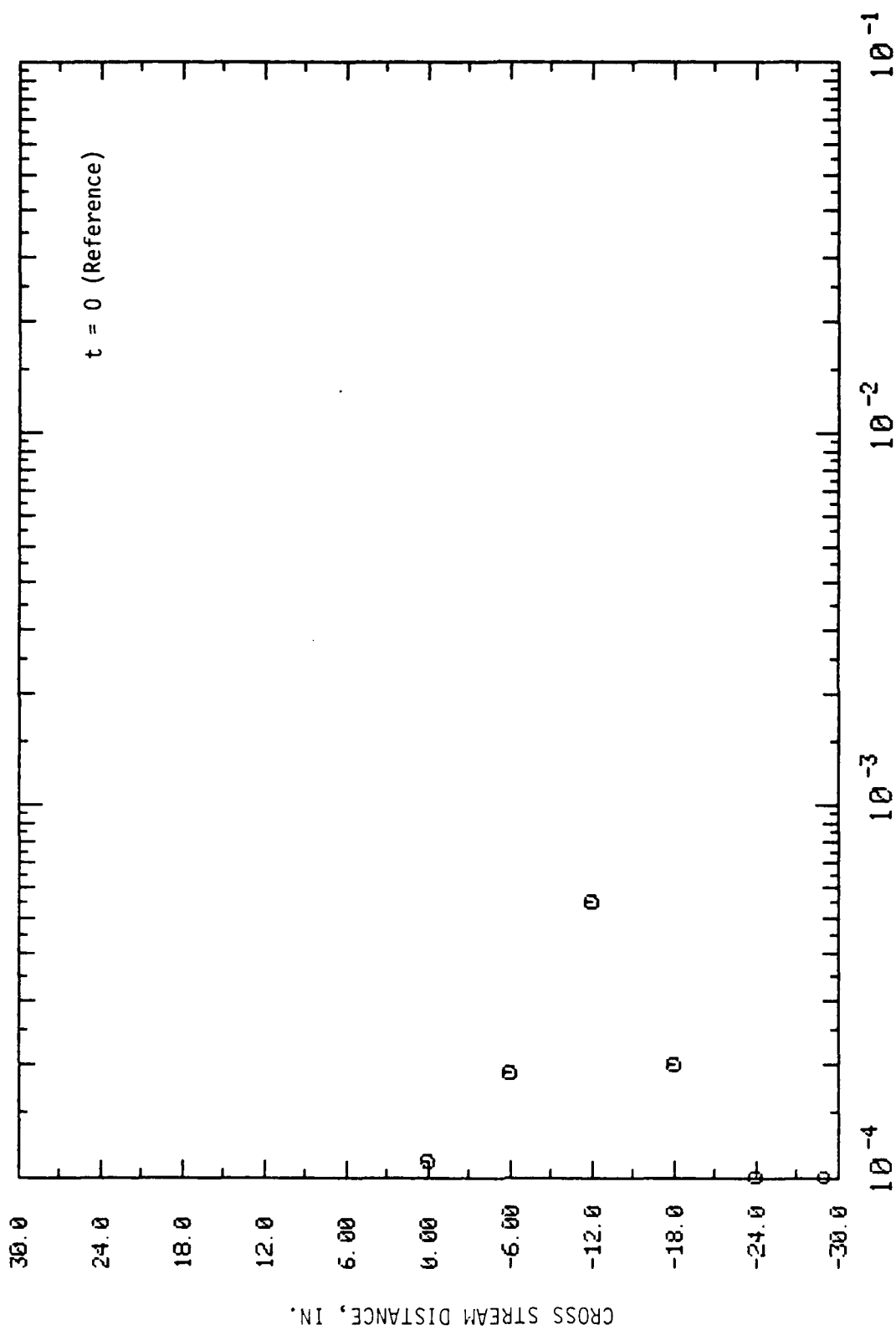
Time elapsed from spill to $t=0$ (Reference) for:

time history graph	27 sec.
cross stream profiles	27 sec.
vertical profiles	27 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

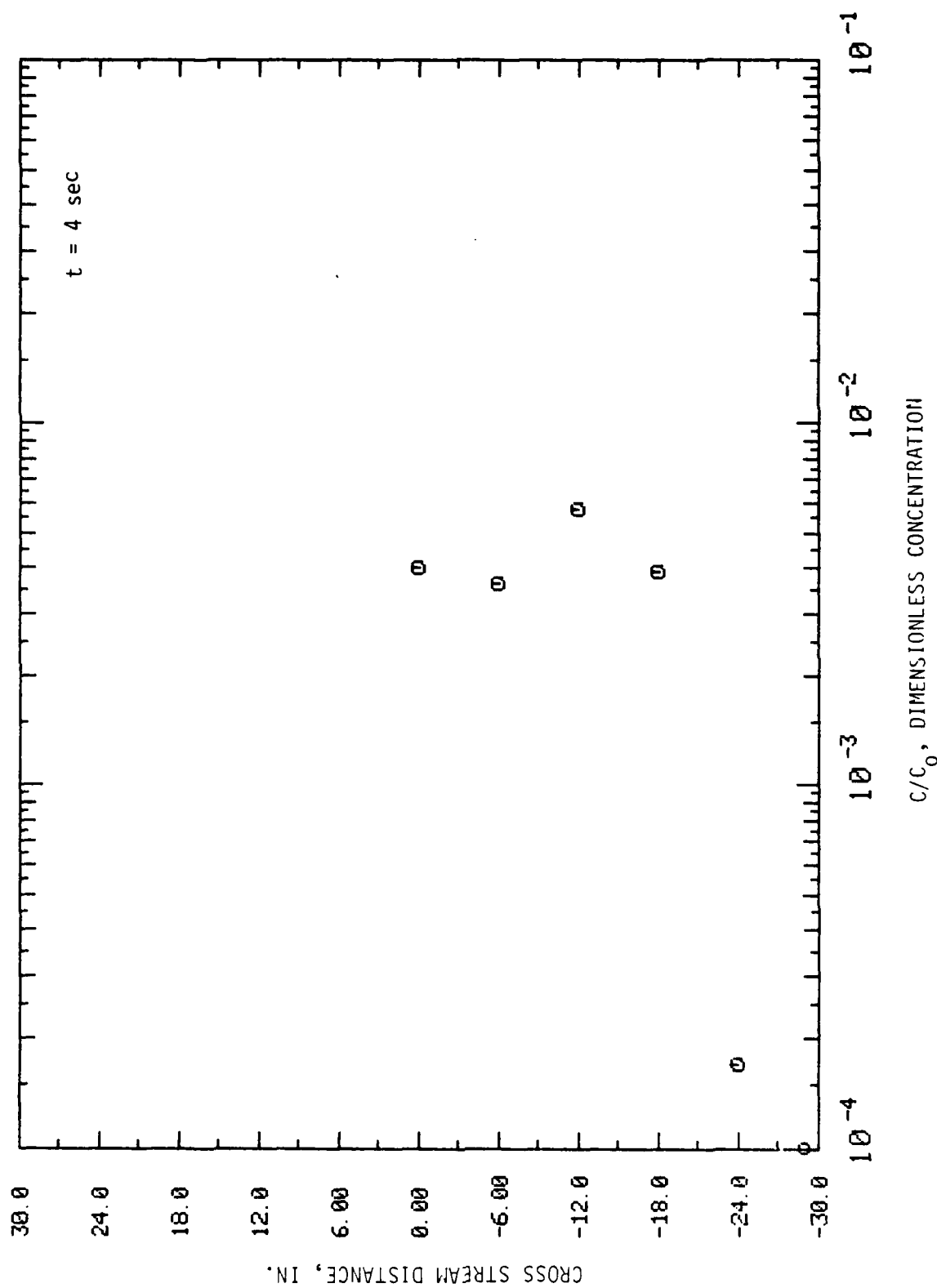
FIGURE F-1. RUN II.1-8B CONCENTRATION TIME HISTORY



C/C_0 , DIMENSIONLESS CONCENTRATION

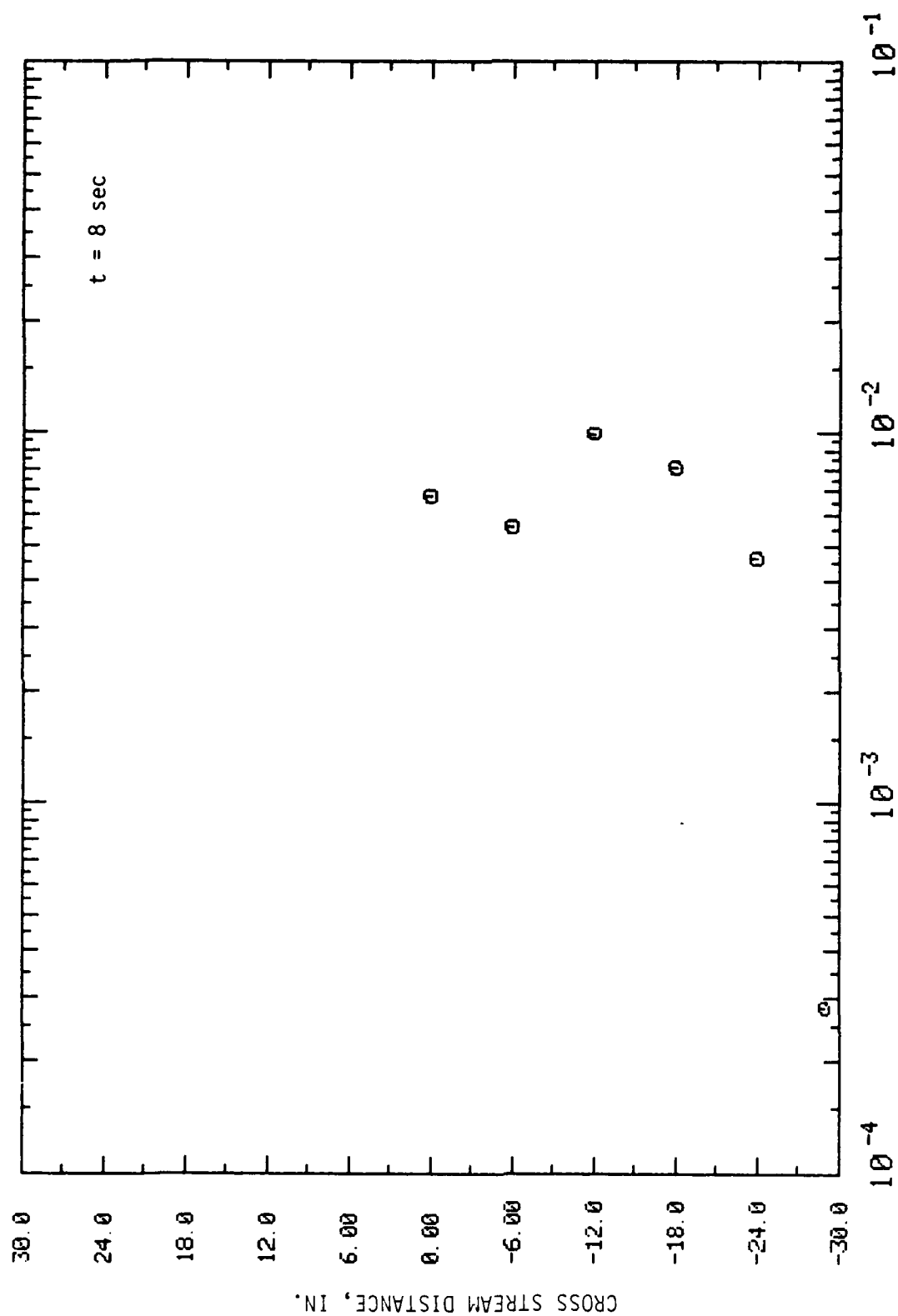
$X = 168$ IN., $Z = 9.25$ IN.

FIGURE F-2. RUN 11.1-8B CROSS STREAM CONCENTRATION PROFILE



$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

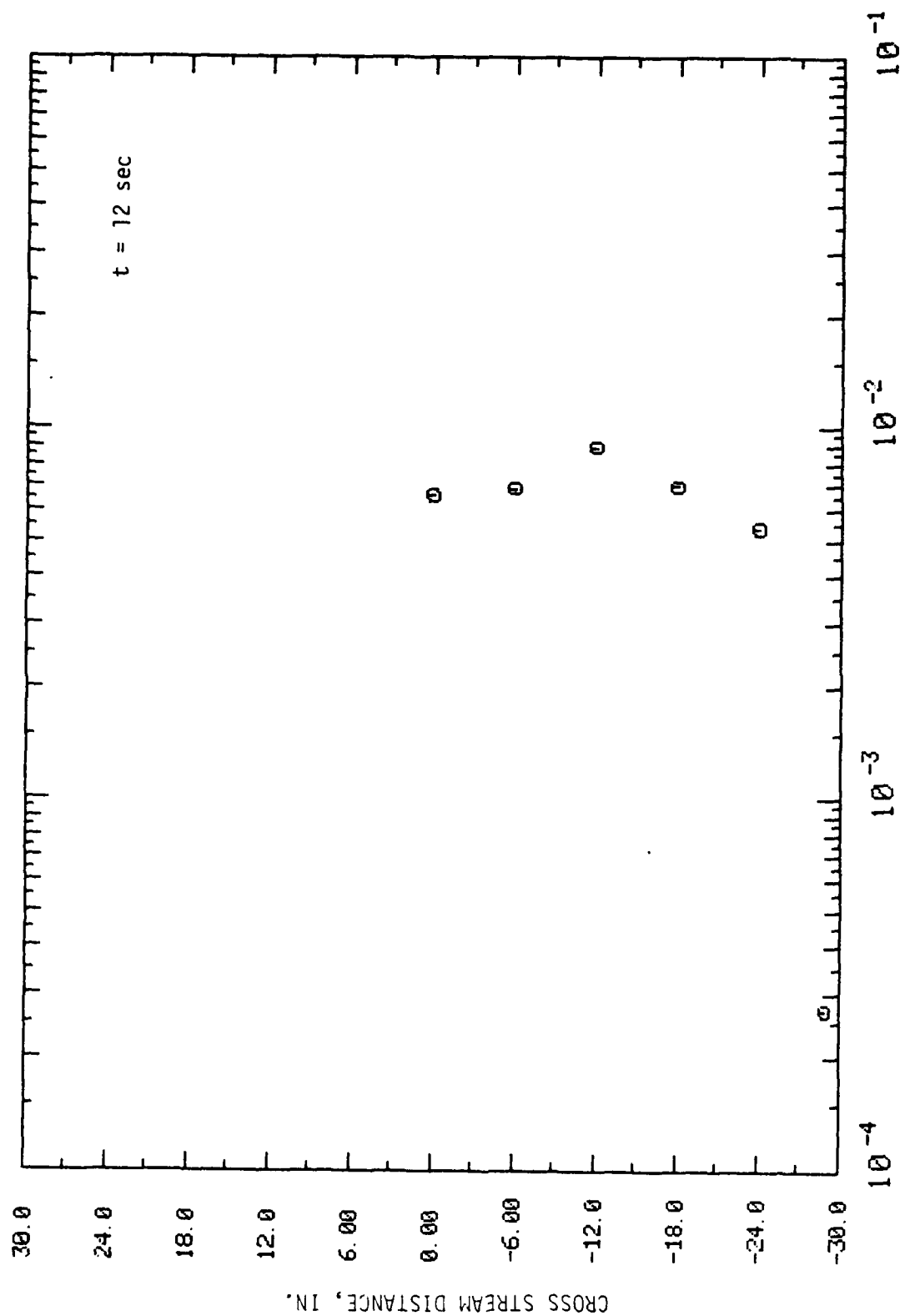
FIGURE F-3 . RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

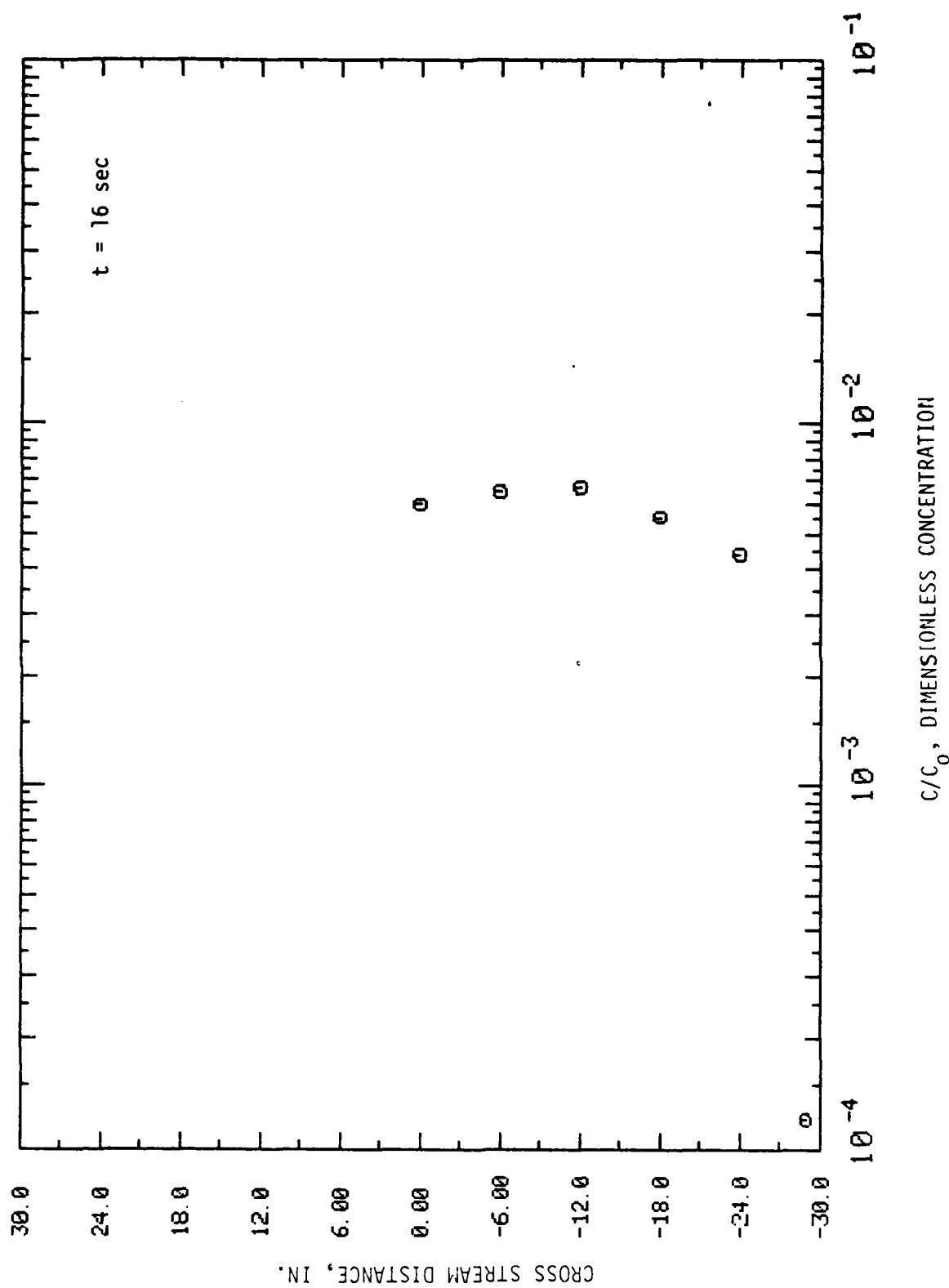
FIGURE F-4. RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

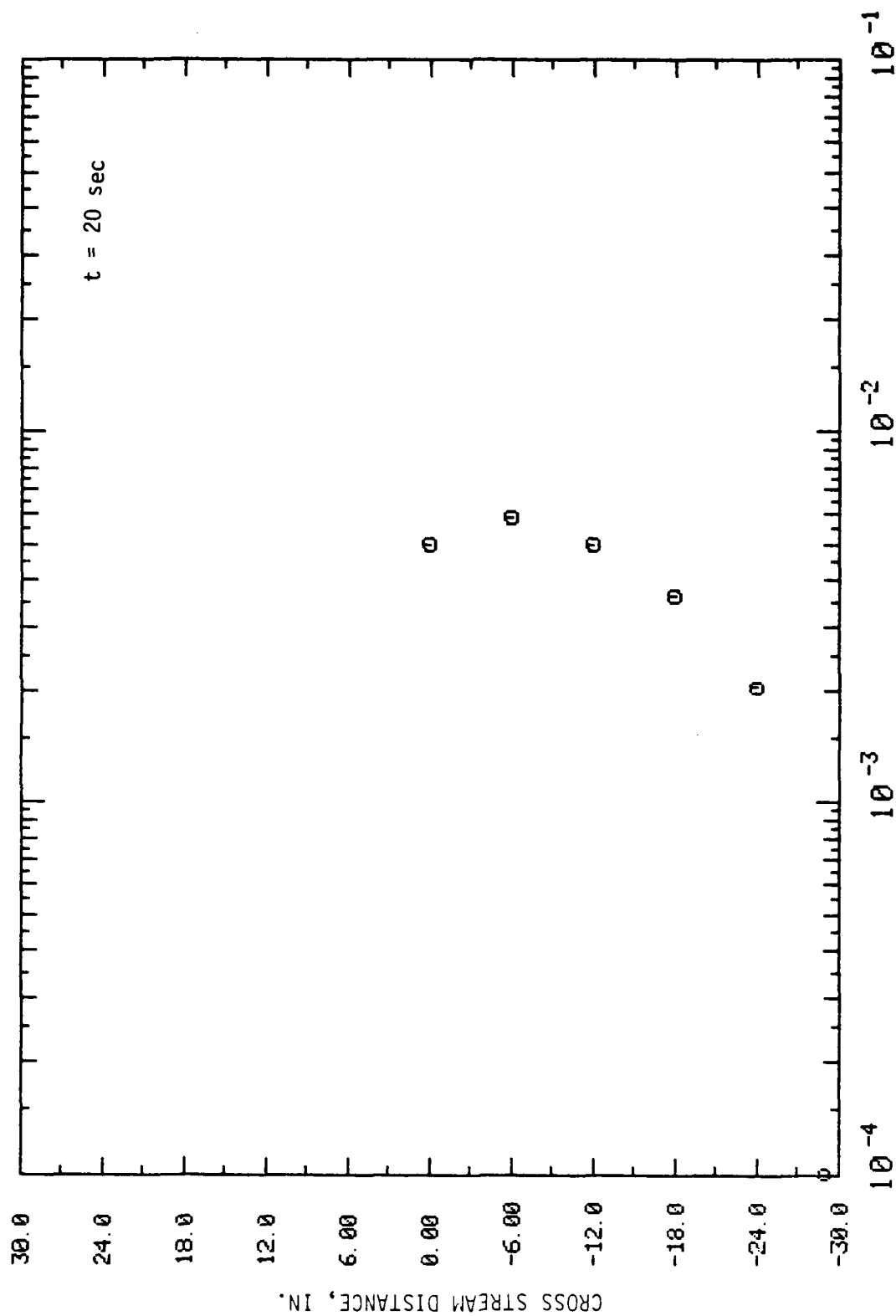
$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-5 . RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE



$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

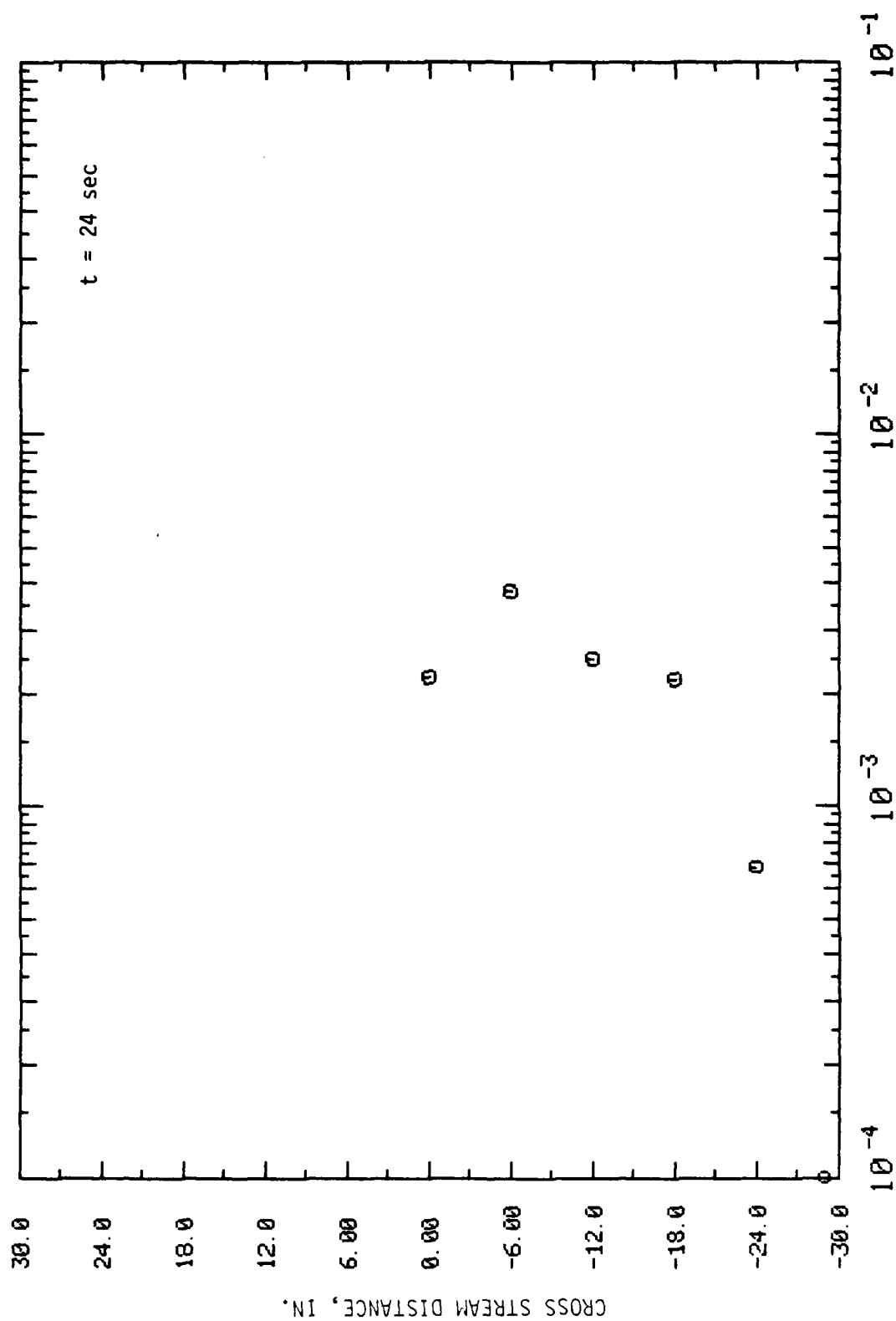
FIGURE F-6. RUN 11.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-7. RUN 11.1-88 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-8 . RUN II.1-88 CROSS STREAM CONCENTRATION PROFILE

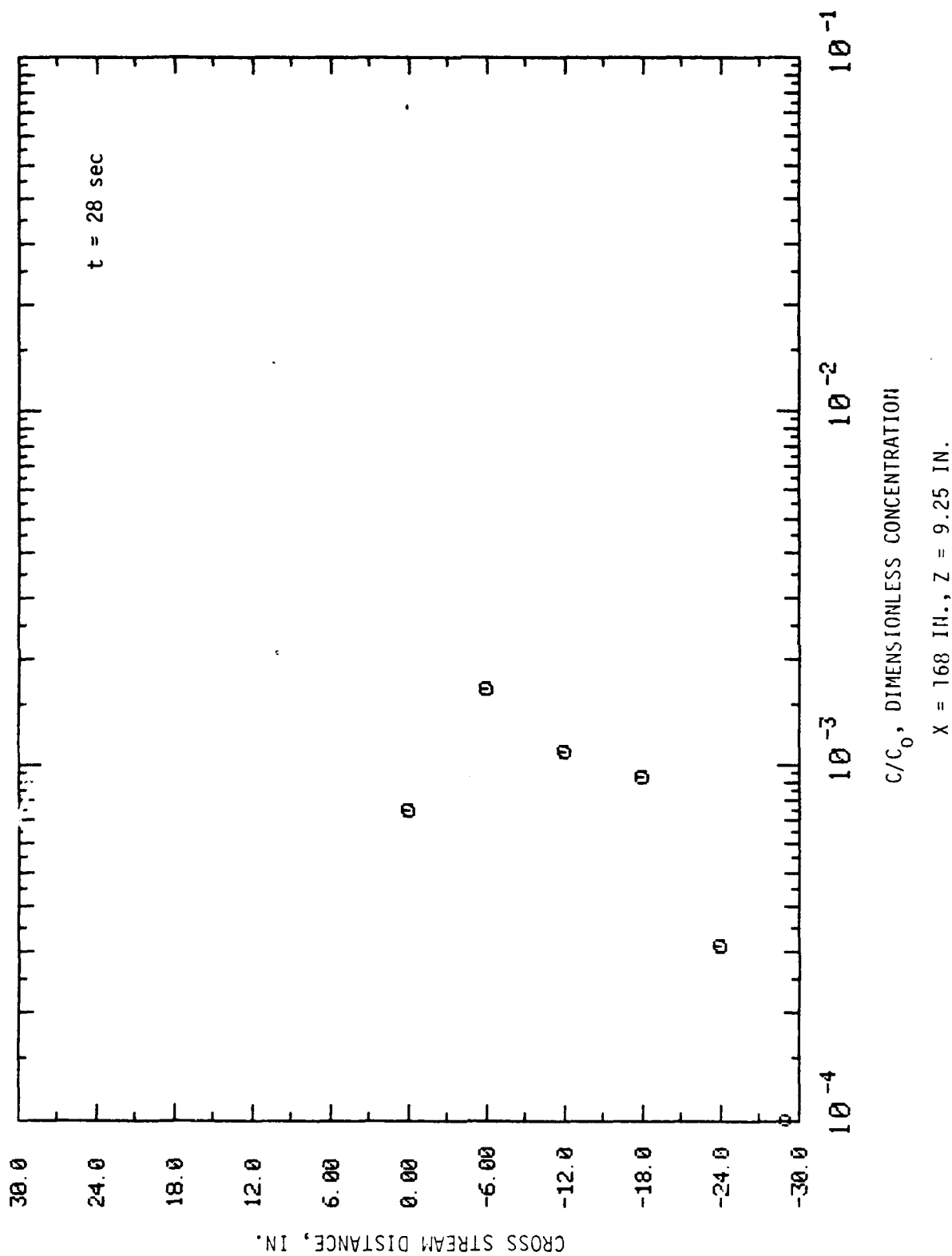
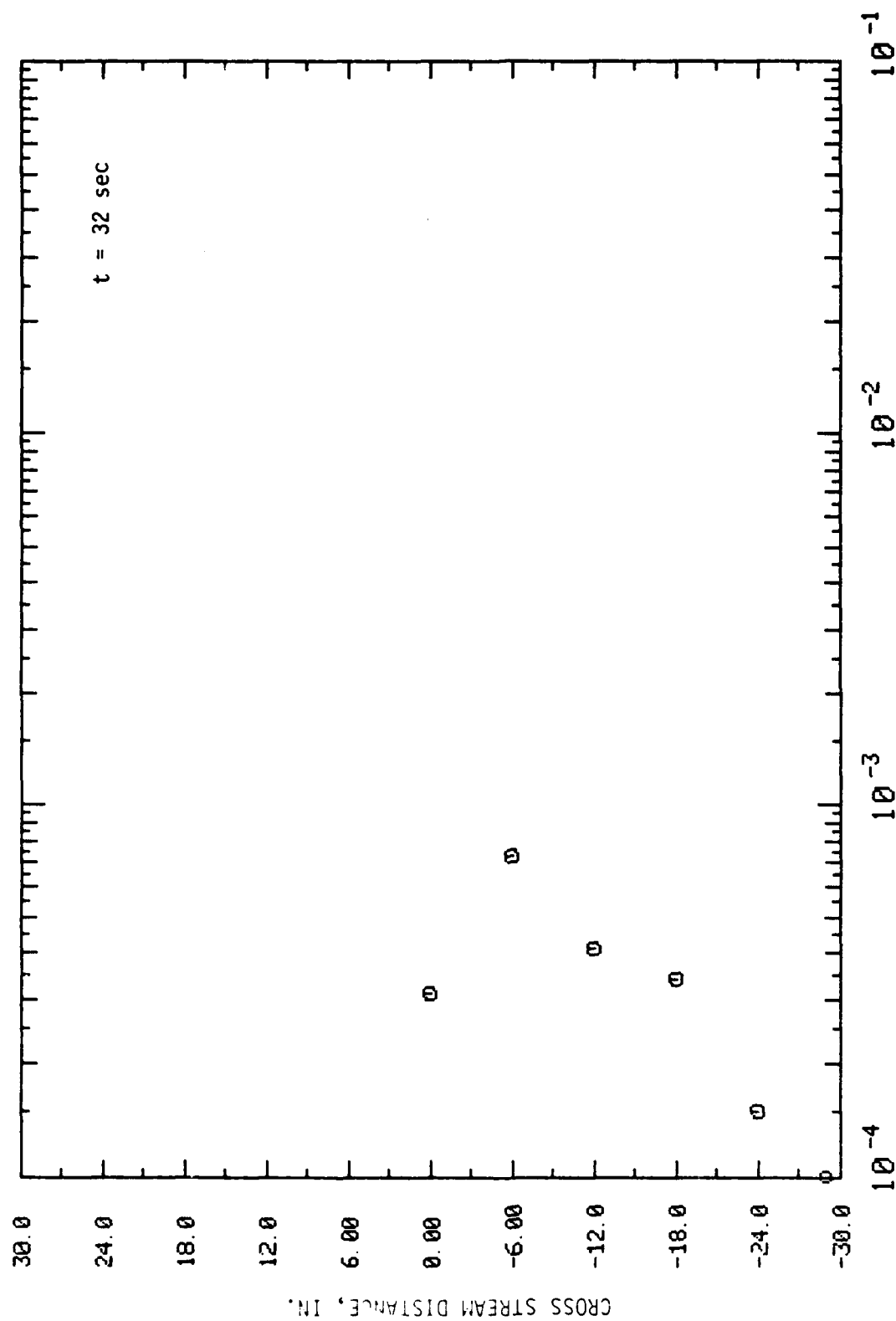


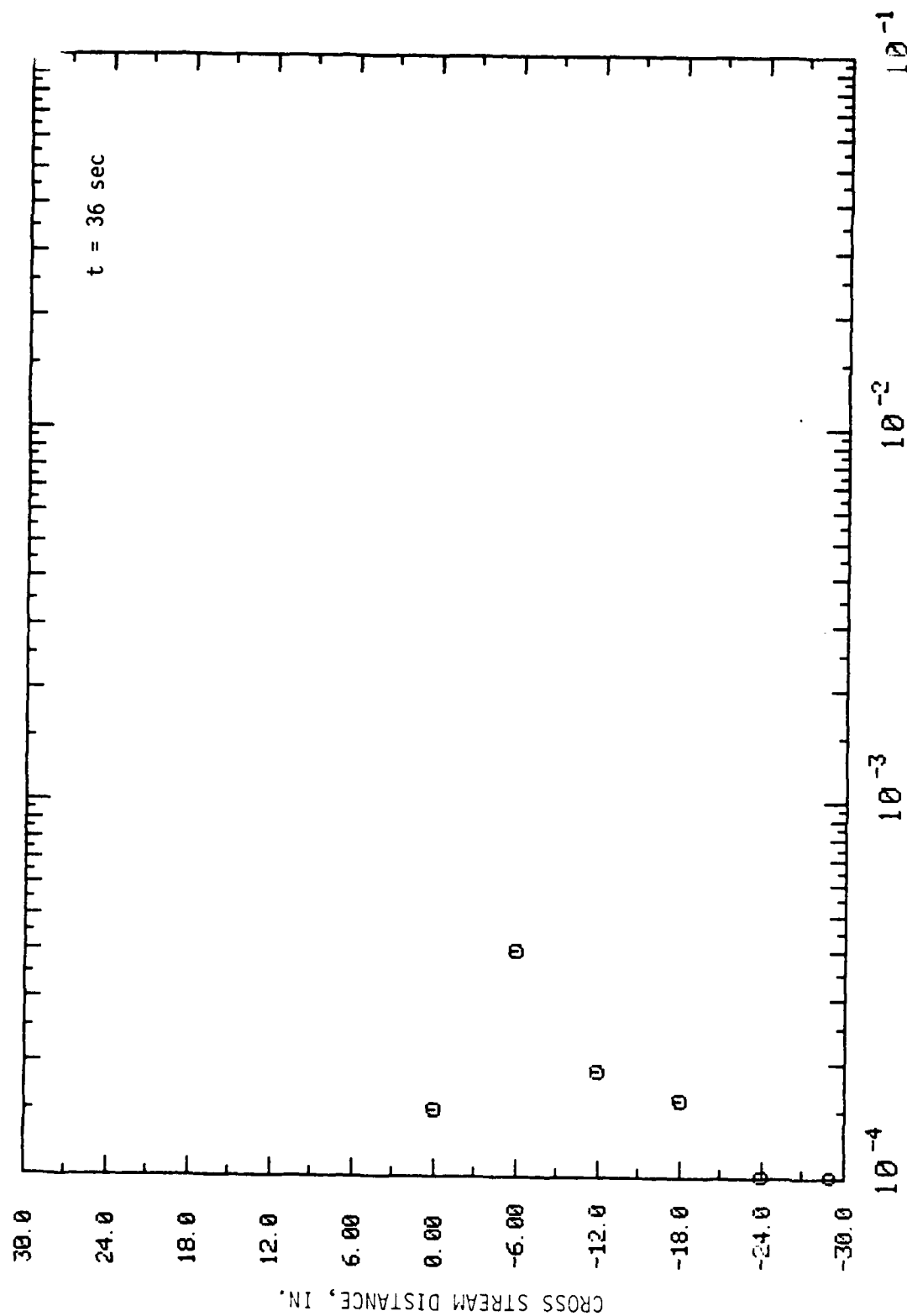
FIGURE F-9. RUN 11.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-10. RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-11. RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE

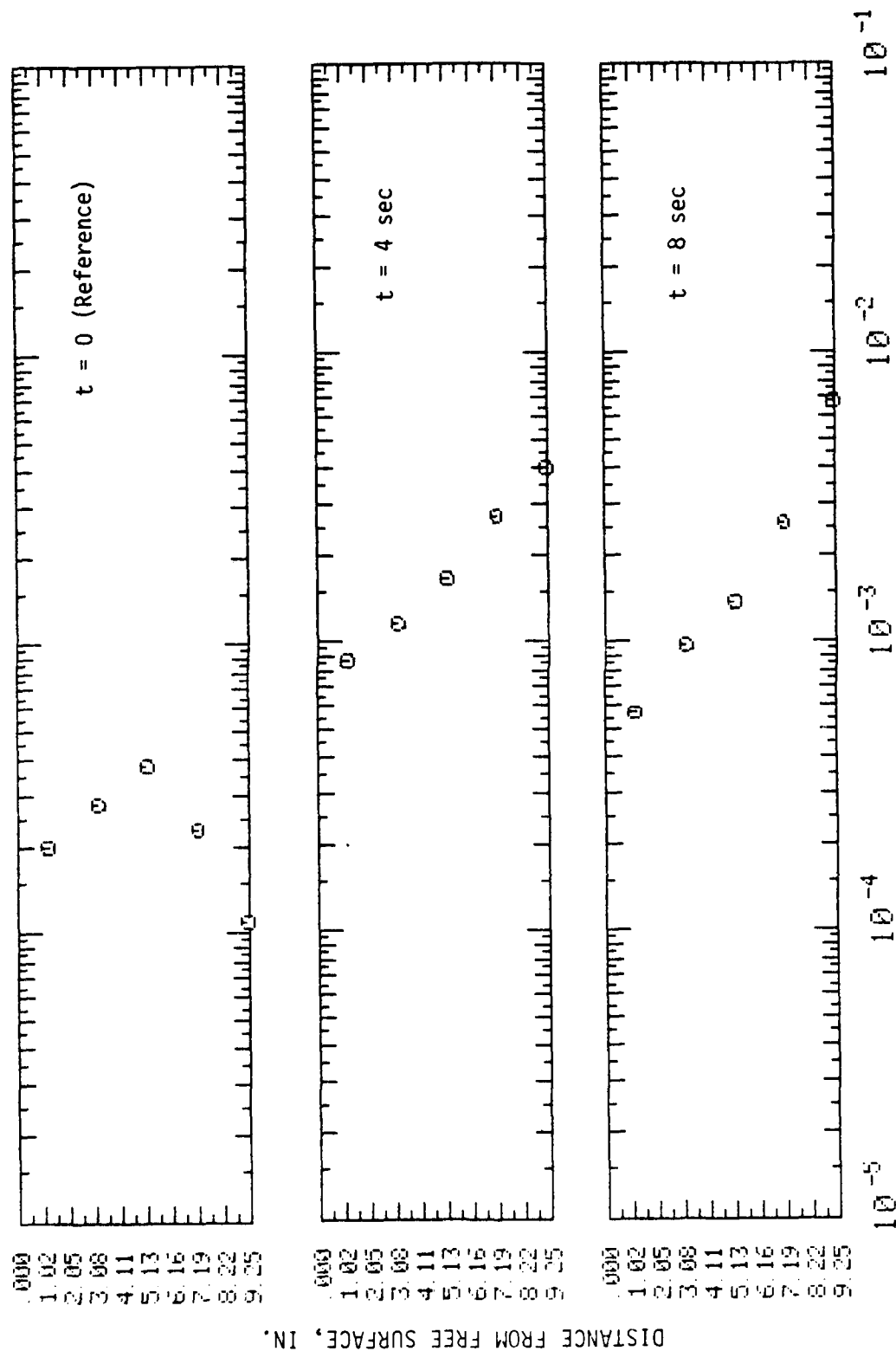
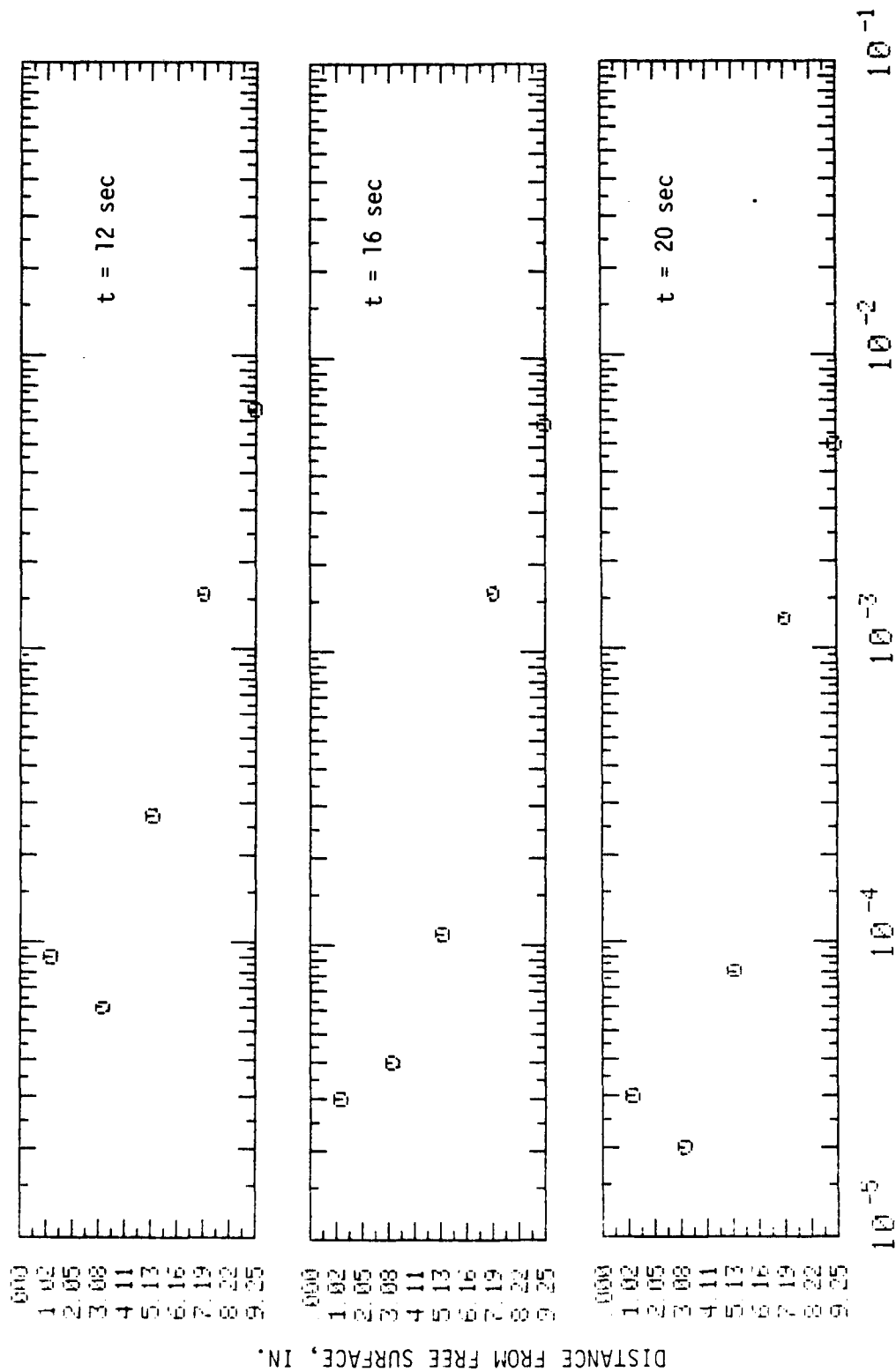


FIGURE F-12. RUN II.1-83 VERTICAL CONCENTRATION PROFILES



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0

FIGURE F-13. RUN II.1-88 VERTICAL CONCENTRATION PROFILES

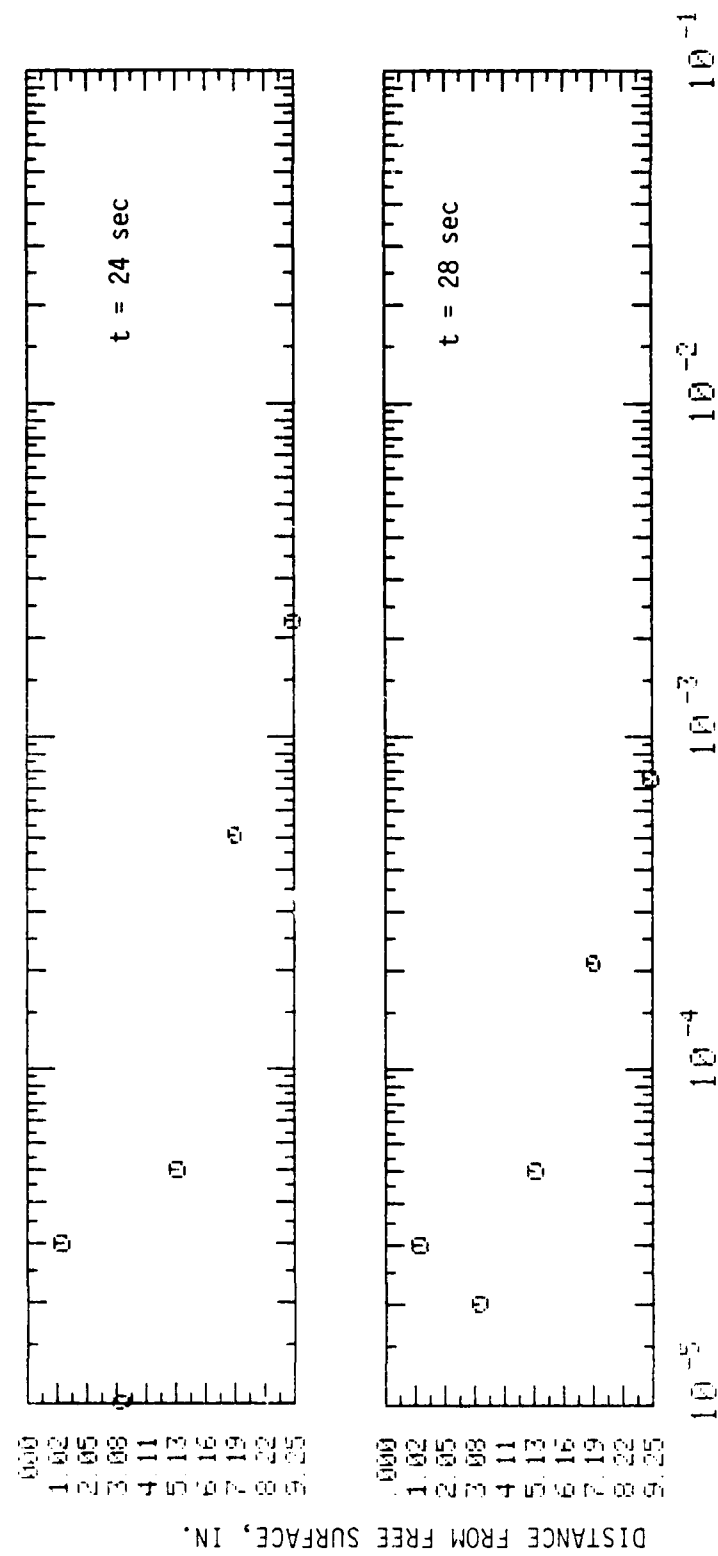


FIGURE F-14. RUN 11.1-88 VERTICAL CONCENTRATION PROFILES

AD-A126 005

ANALYTICAL AND EXPERIMENTAL STUDY TO IMPROVE COMPUTER
MODELS FOR MIXING R. (U) SOUTHWEST RESEARCH INST SAN
ANTONIO TX F T DODGE ET AL. AUG 82 USCG-D-2-83

2/2

UNCLASSIFIED

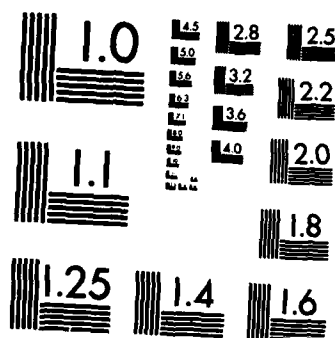
DOT-CG-920622-A

F/G 7/1

NL

END

FILMED
+12-14
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX G

CONCENTRATION PROFILES FOR RUN II.1-13

$$\rho_c/\rho = 1.40 \text{ (Sodium Silicate)}$$

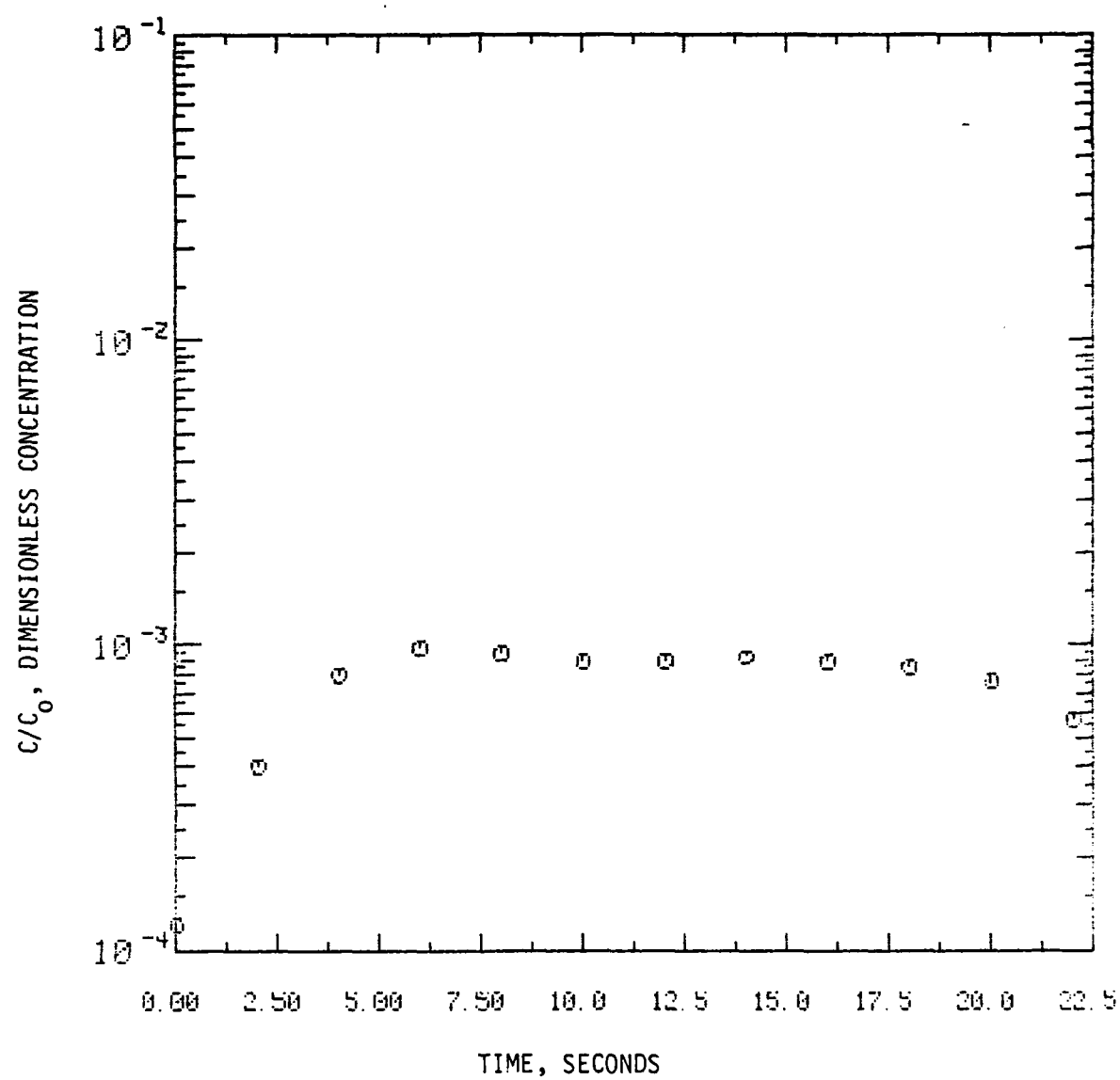
$$r_i/d = 0.125$$

$$u_r/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	31 sec.
cross stream profiles	31 sec.
vertical profiles	29 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

FIGURE G-1. RUN II.1-13 CONCENTRATION TIME HISTORY

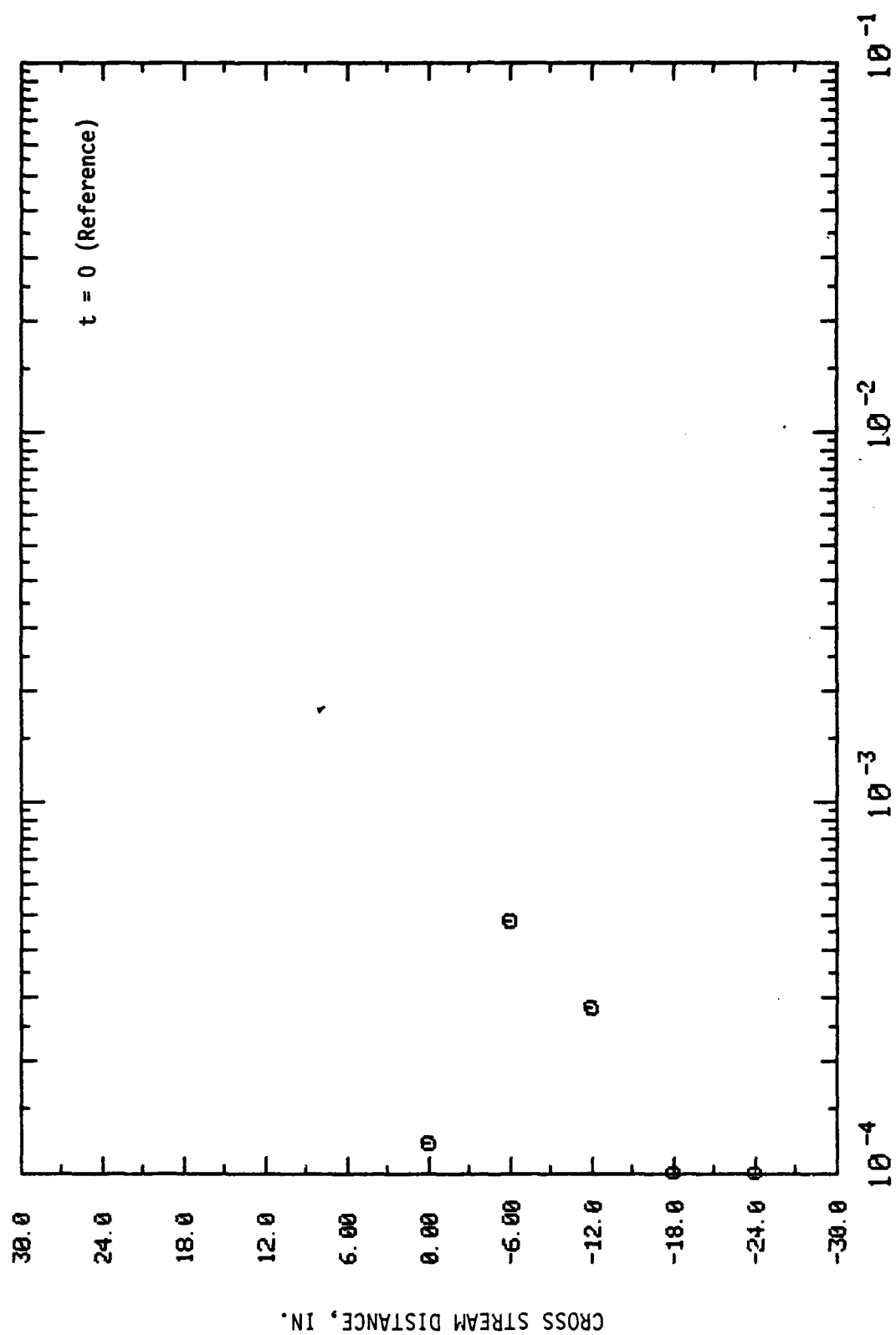
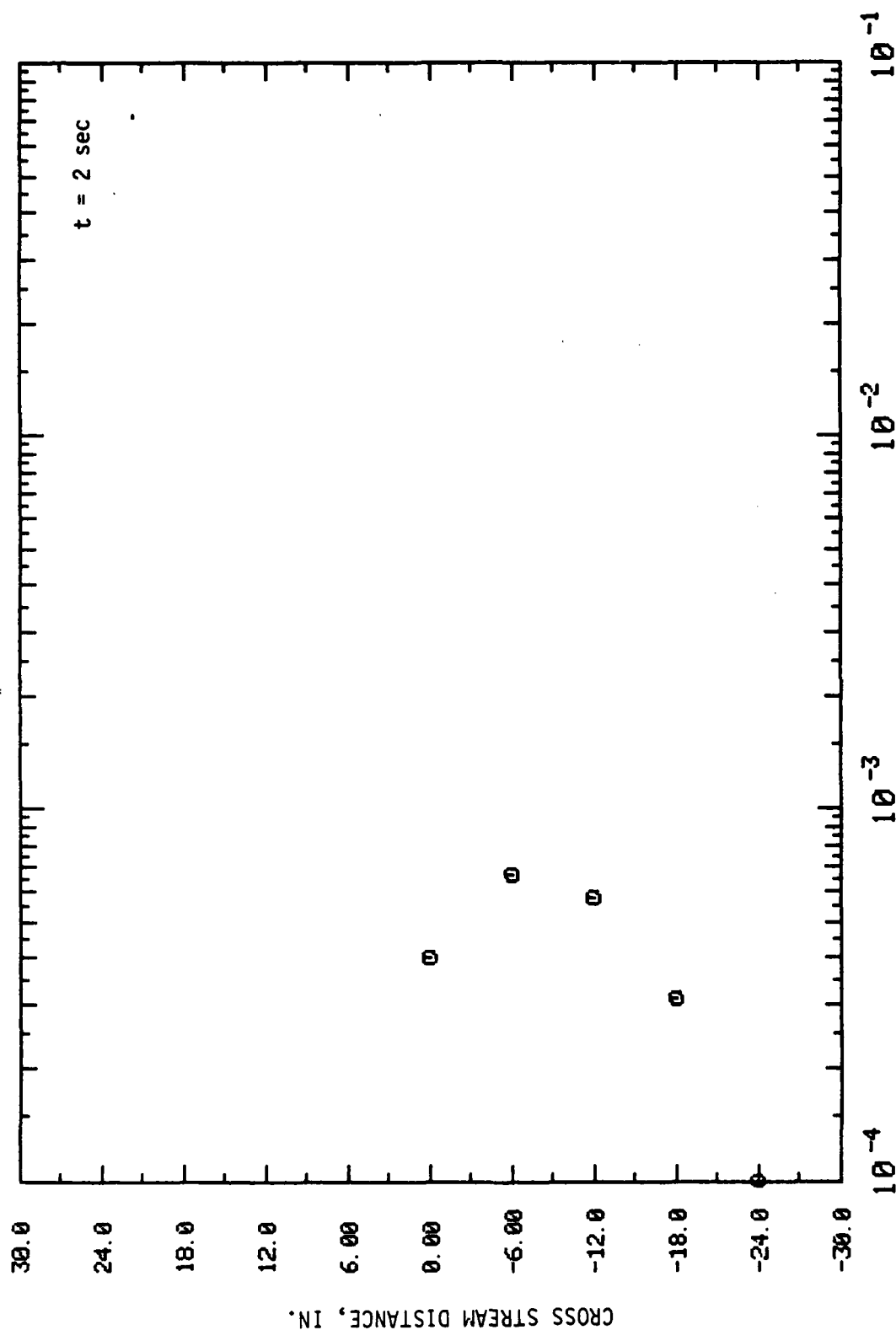


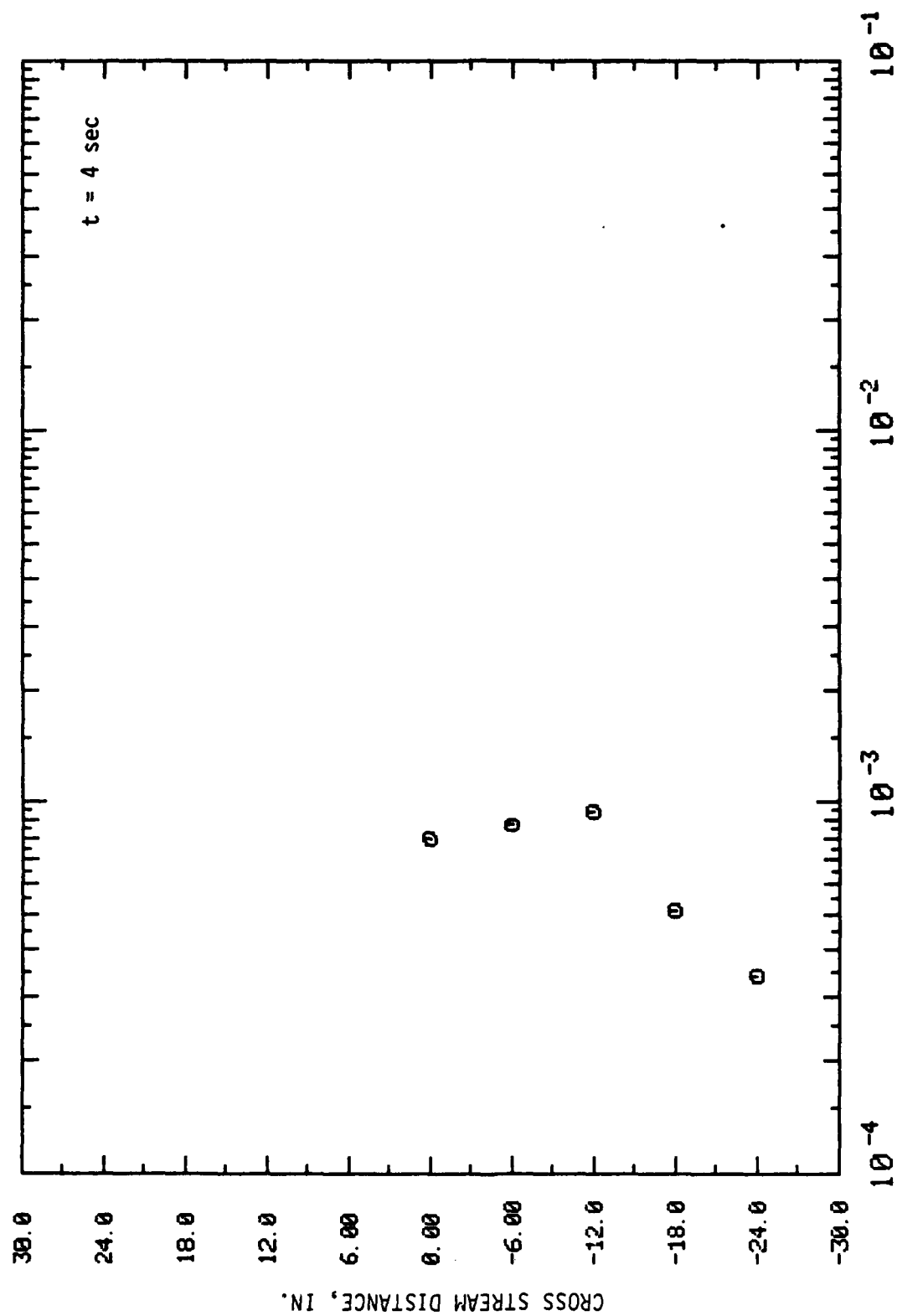
FIGURE G-2. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

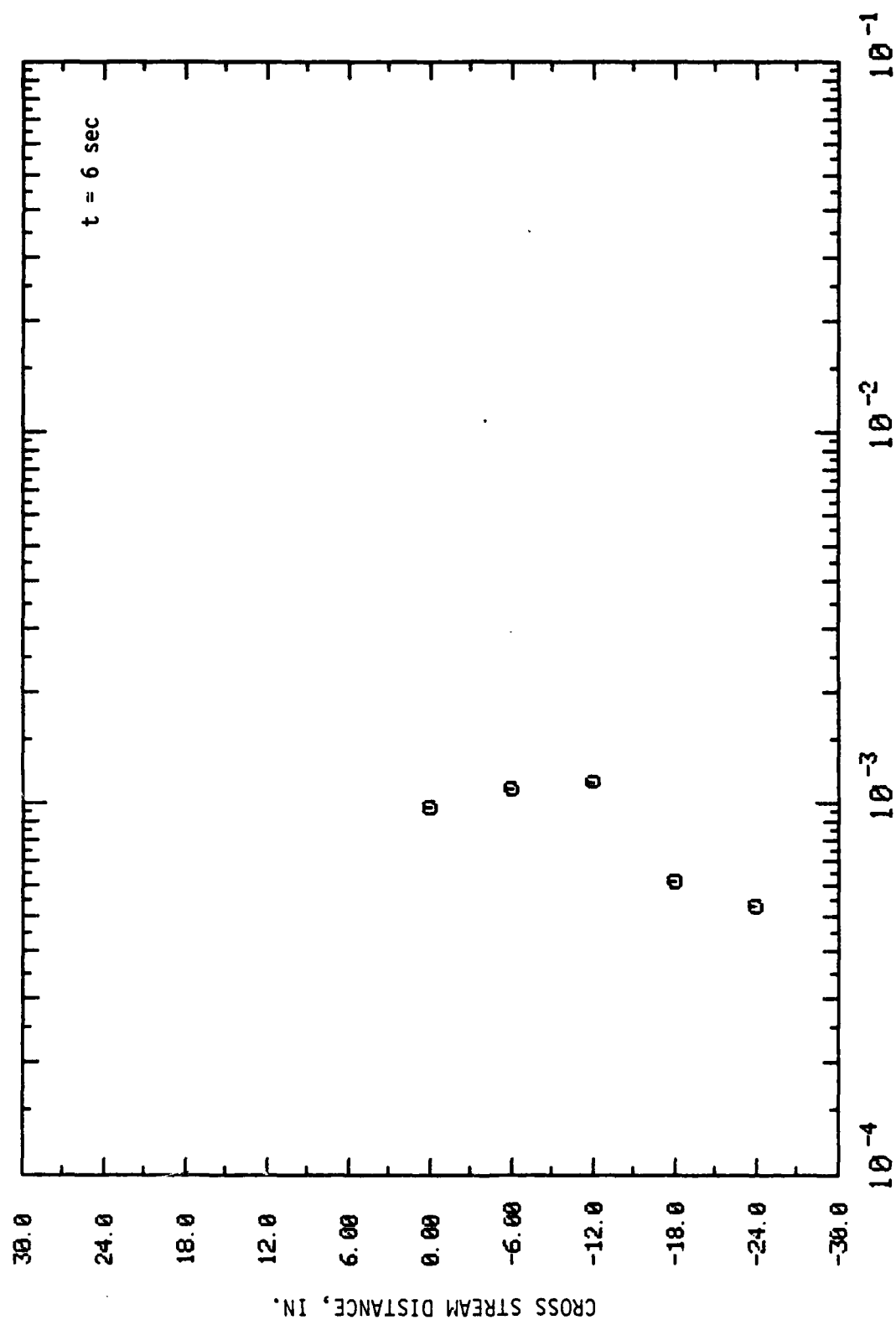
FIGURE G-3. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE G-4. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE G-5. RUN II.1-13 CROSS-STREAM CONCENTRATION PROFILE

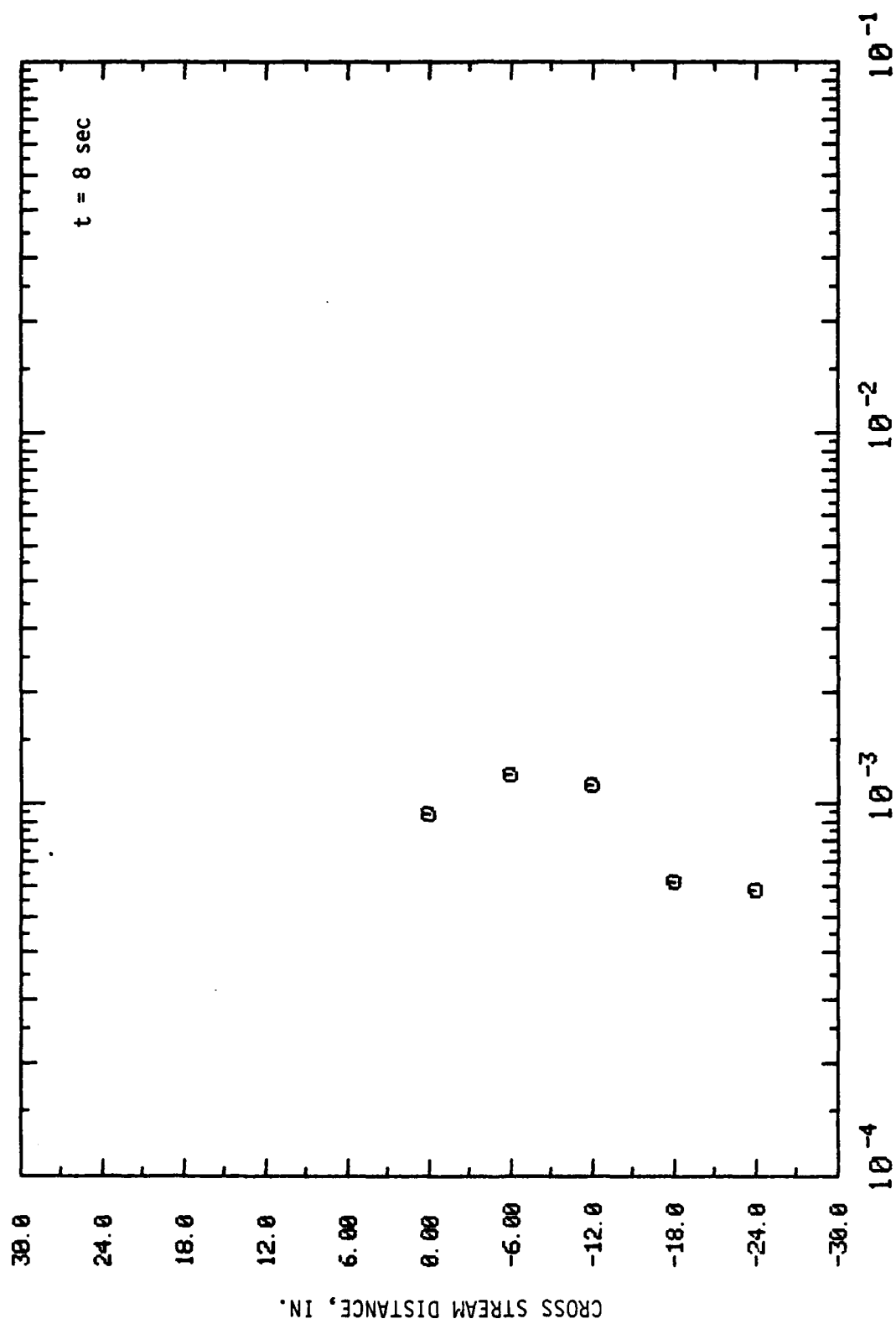
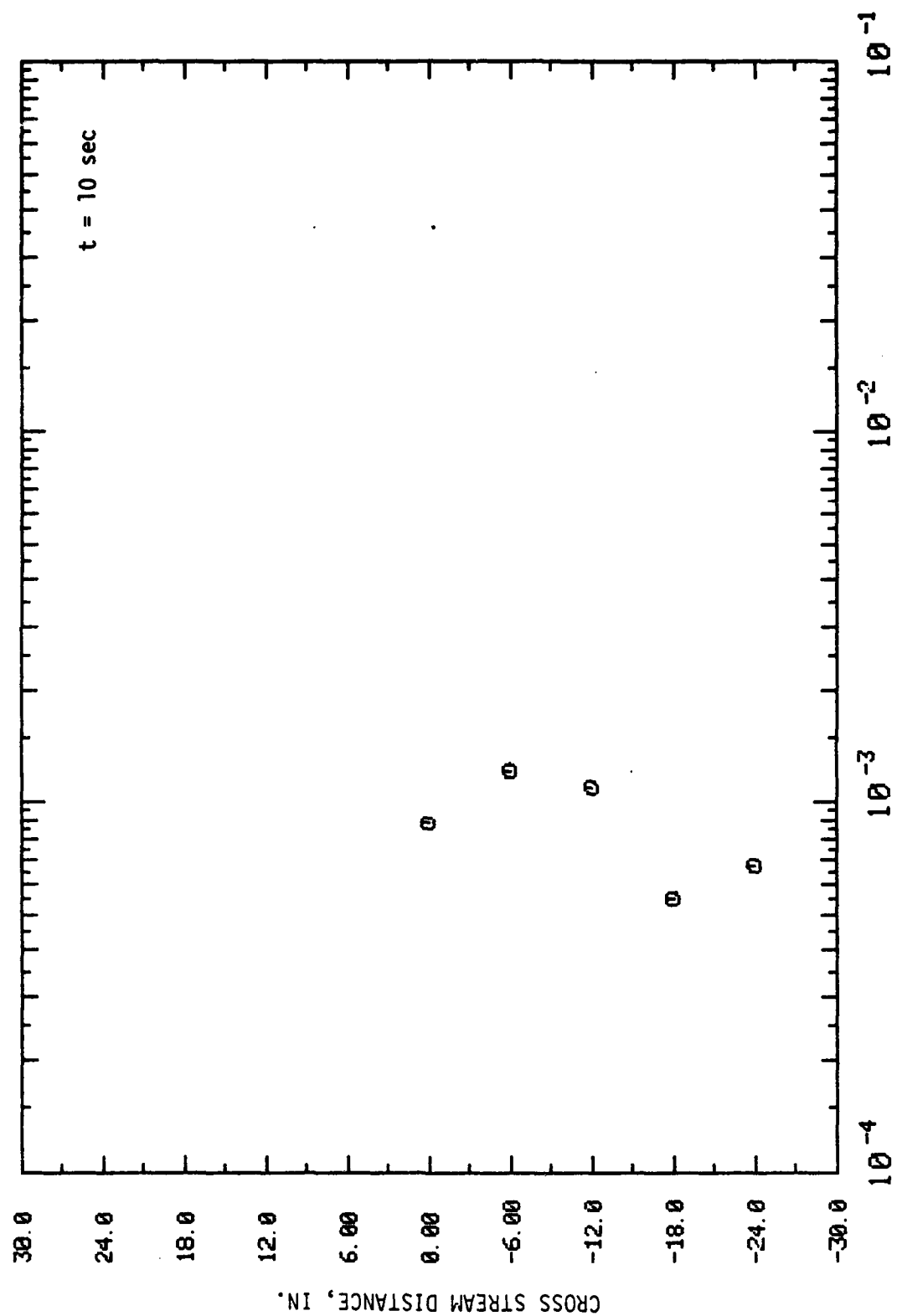


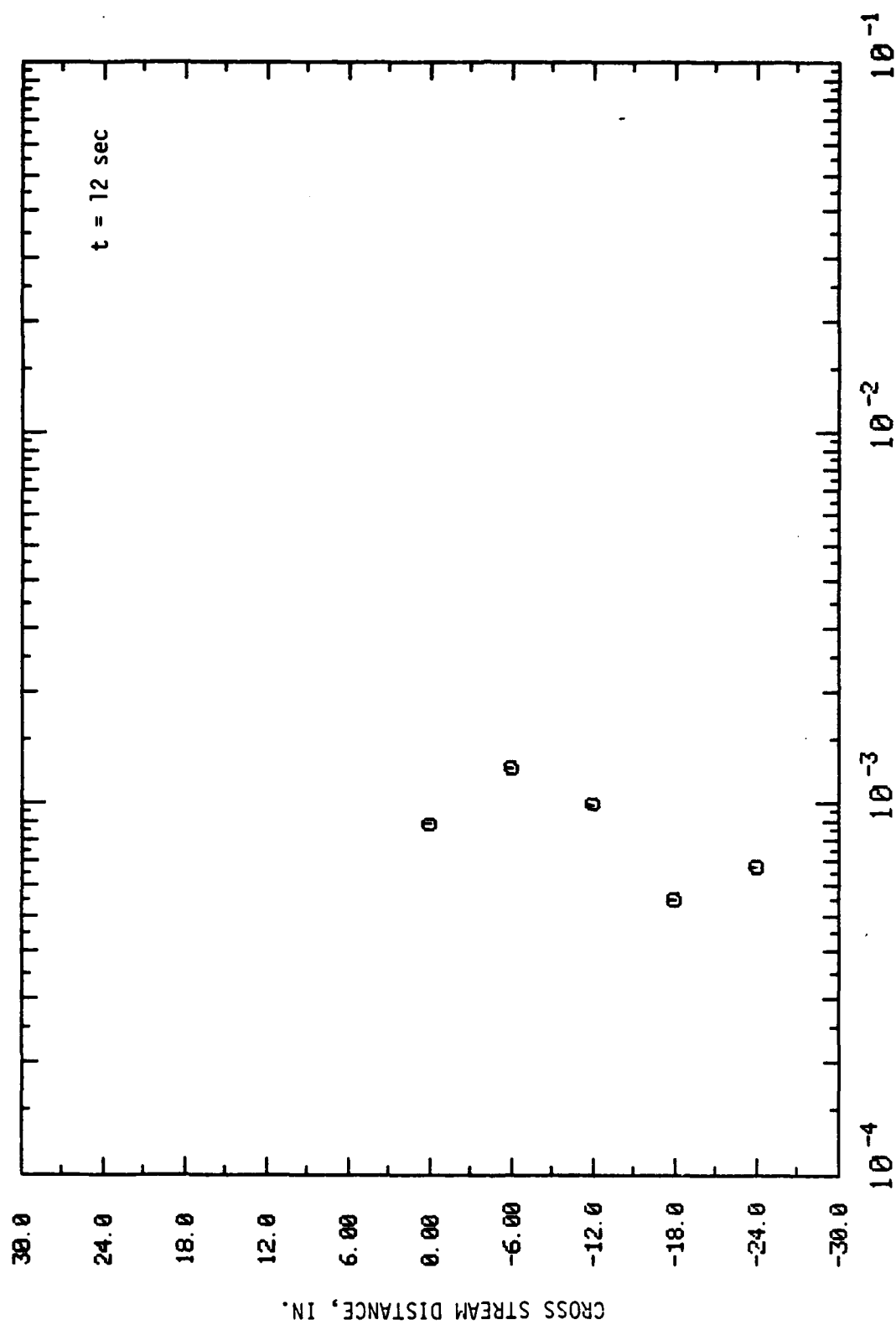
FIGURE G-6. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

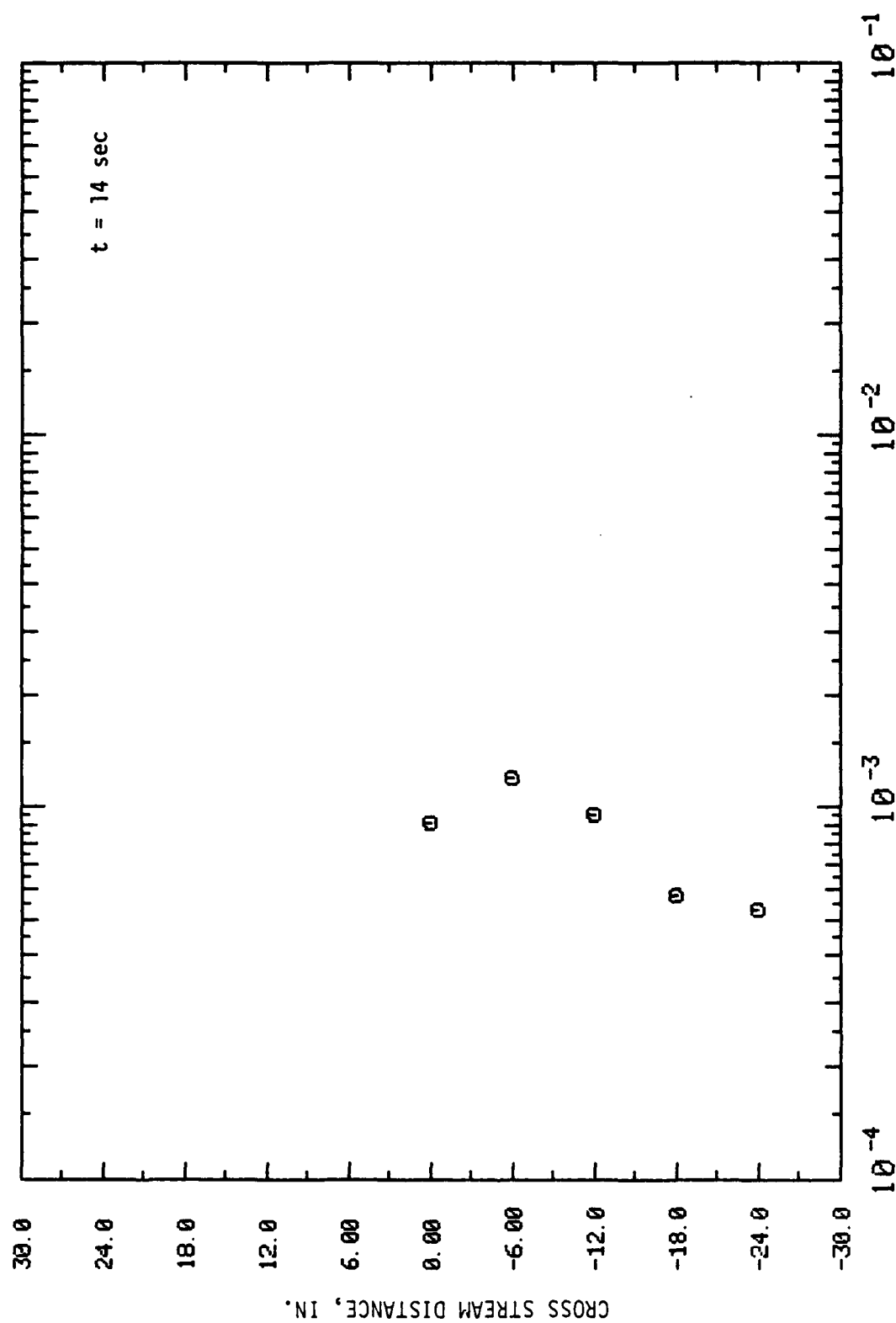
FIGURE G-7. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE G-8. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE G-9. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE

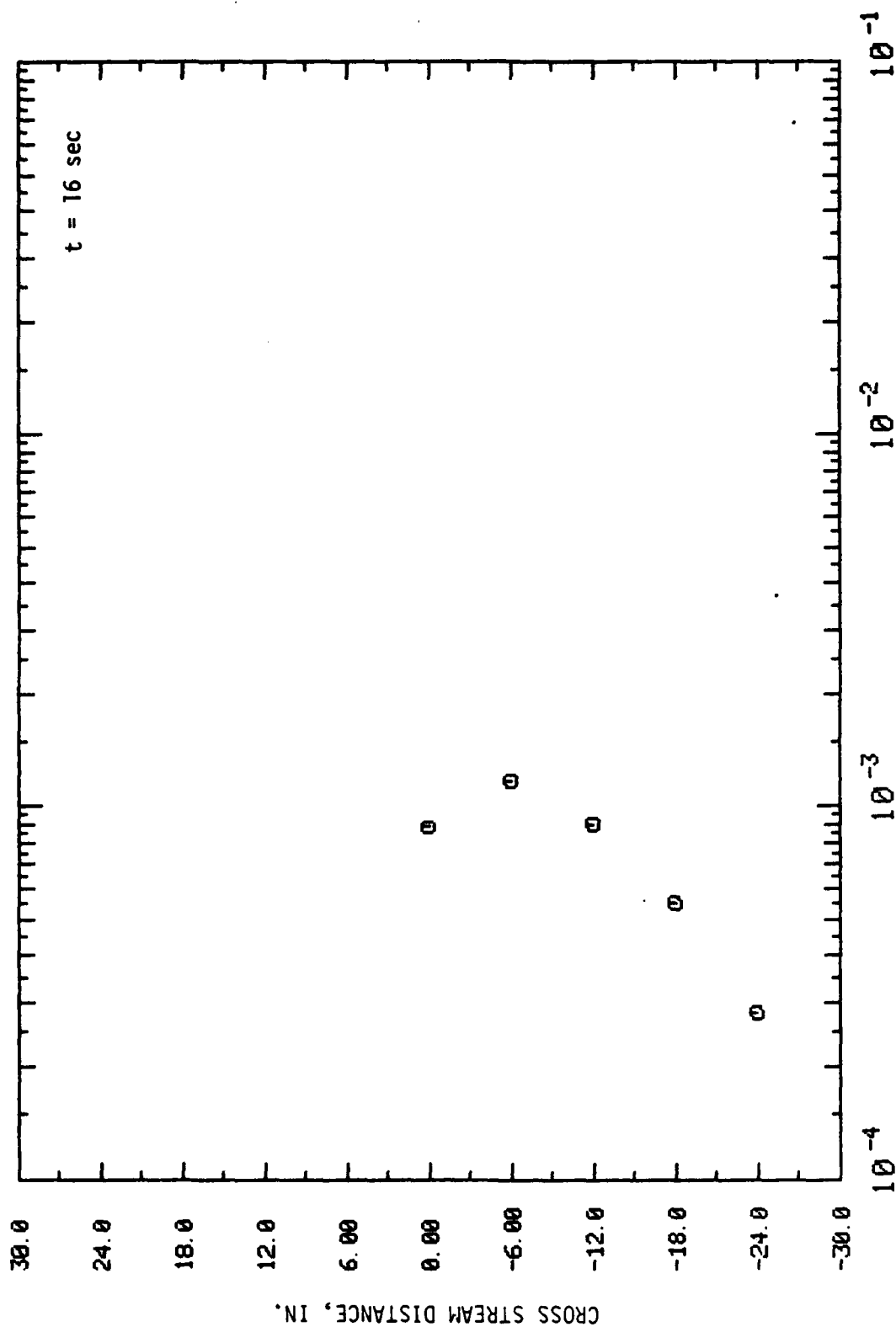
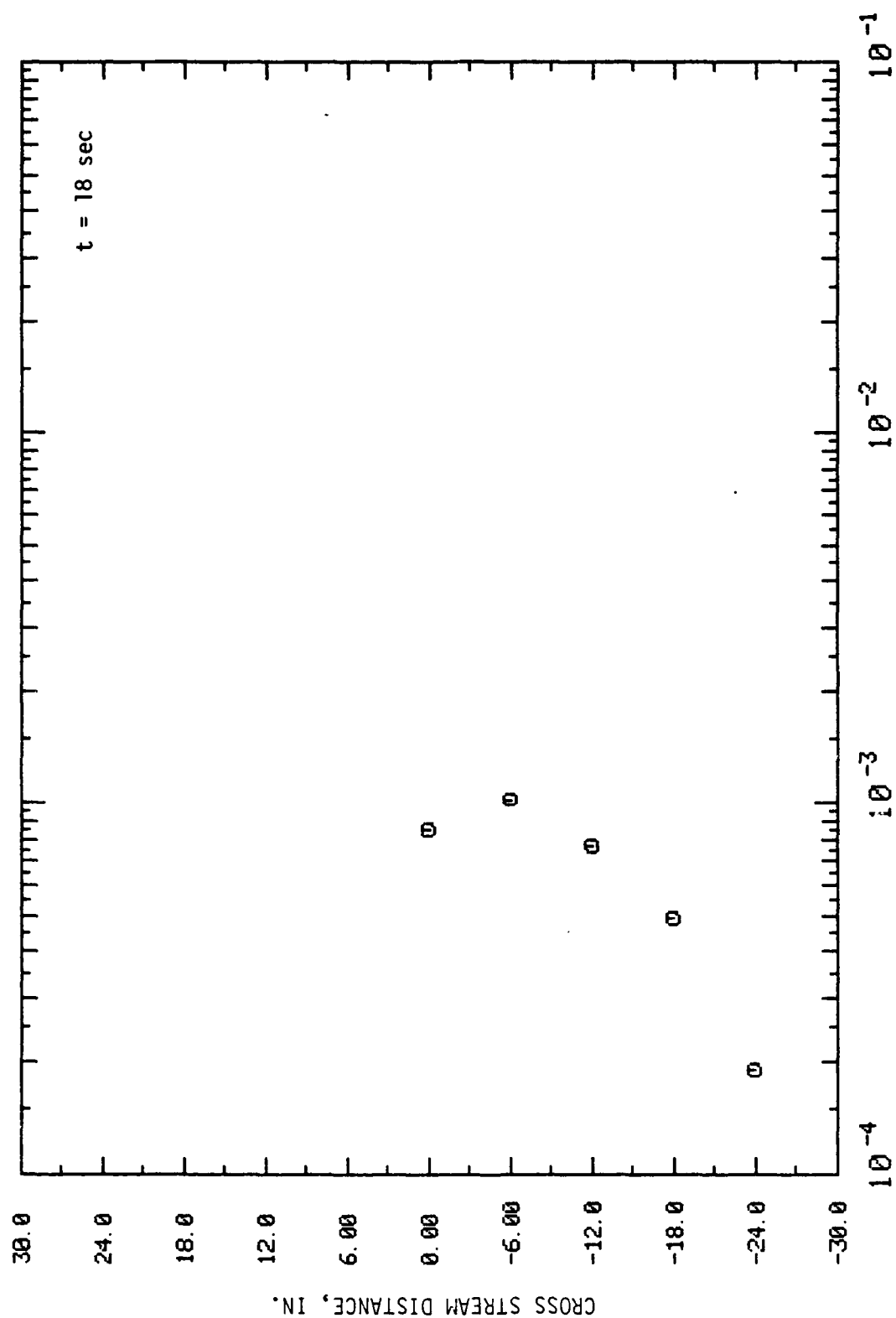


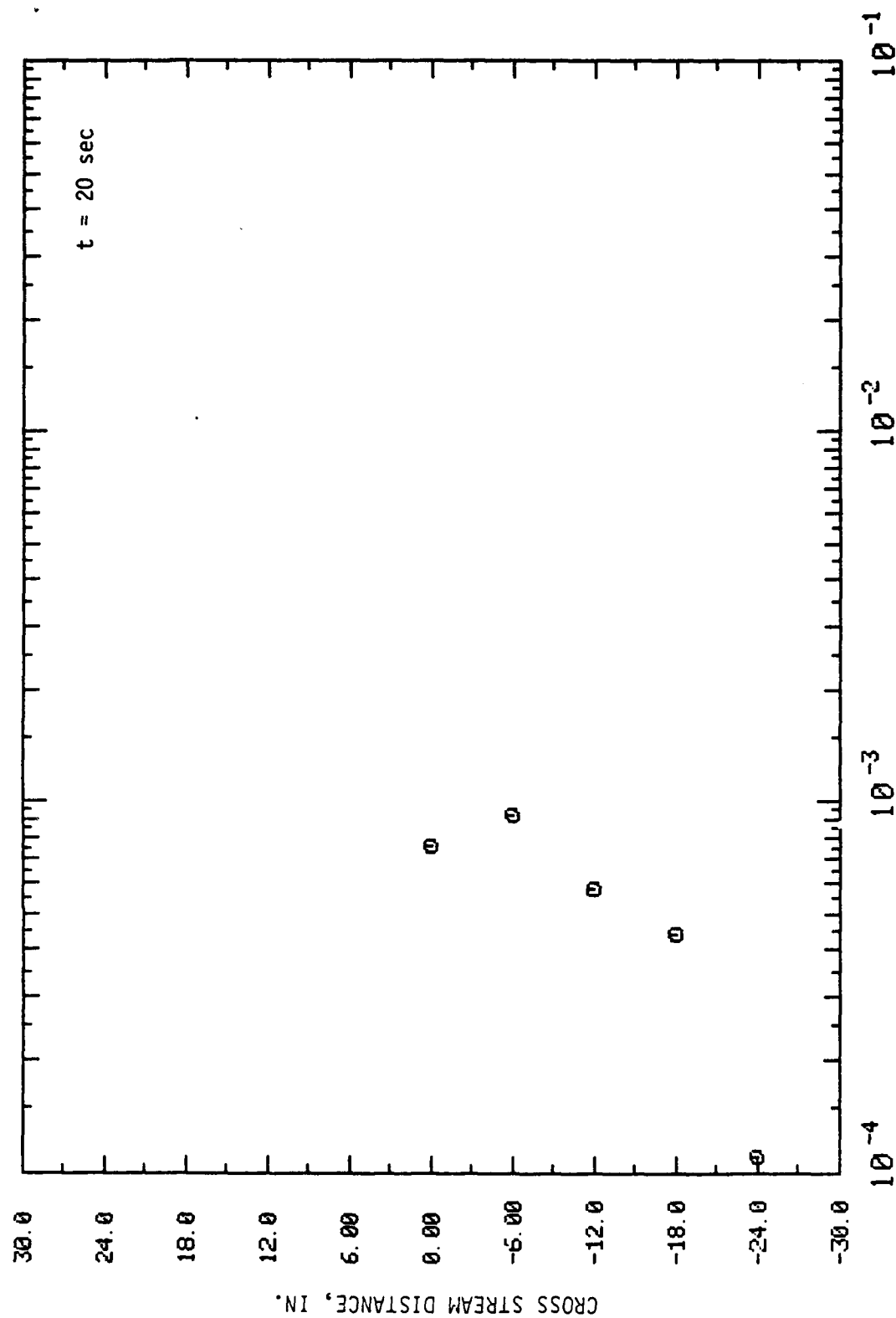
FIGURE G-10. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

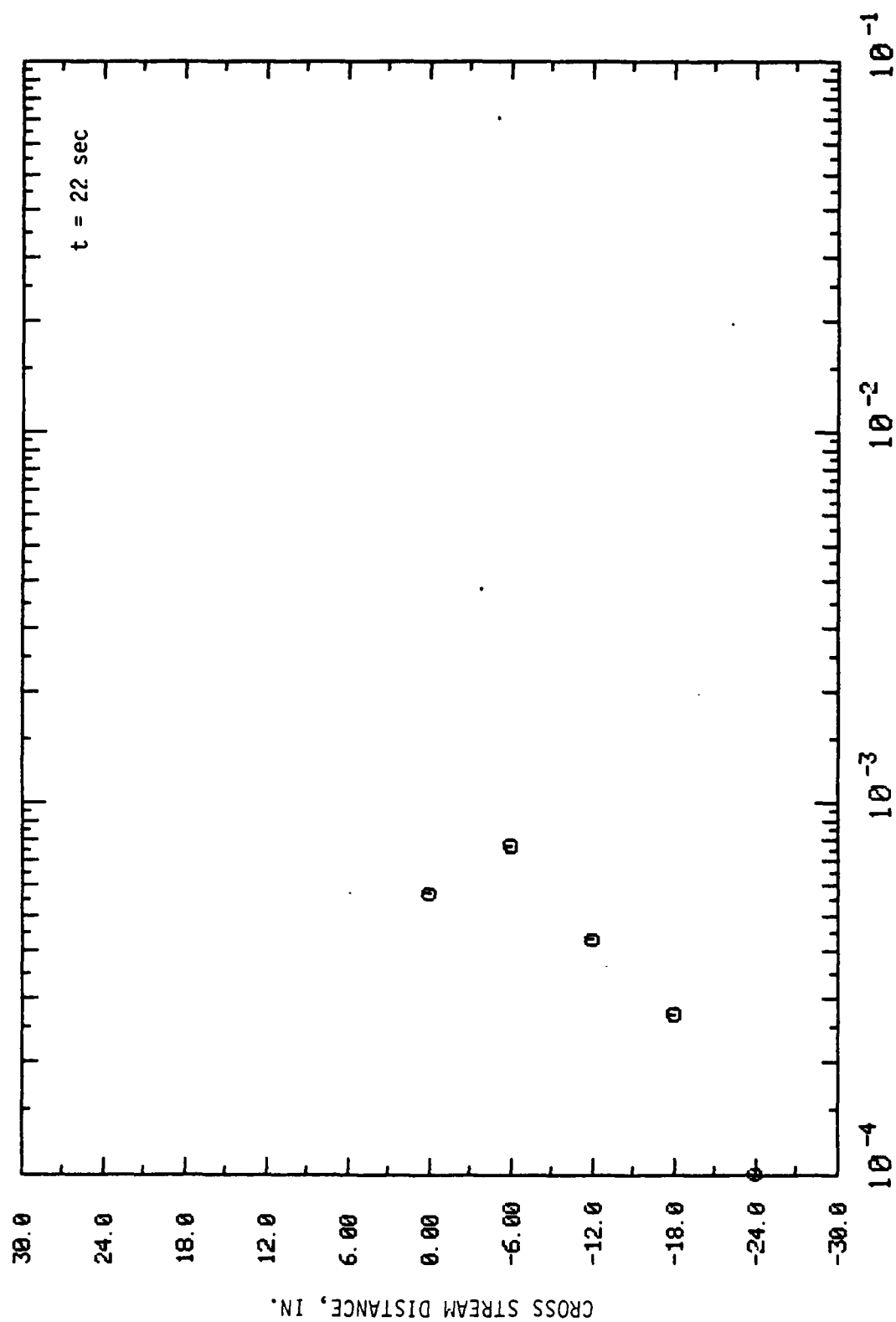
FIGURE G-11. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

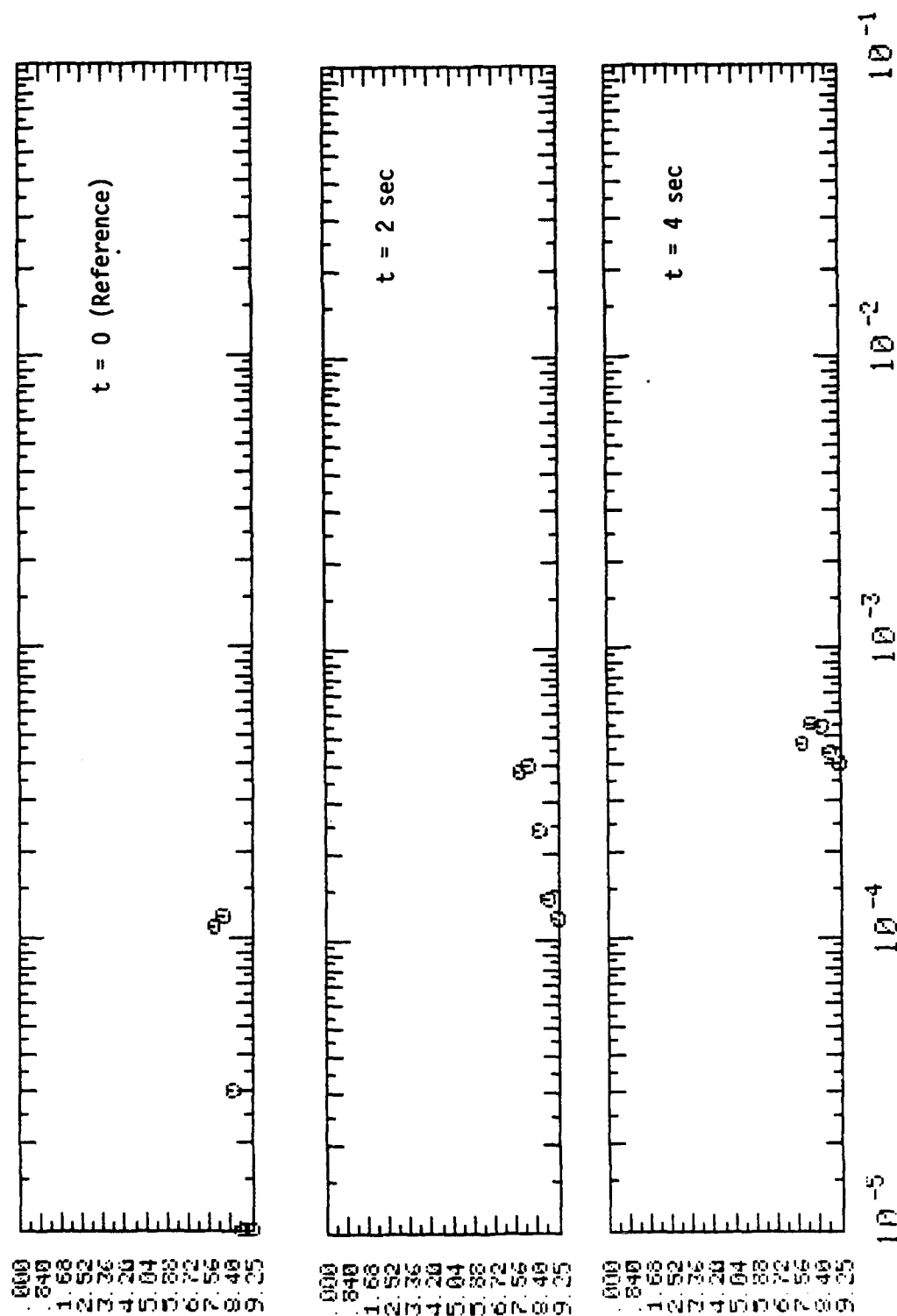
FIGURE G-12. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

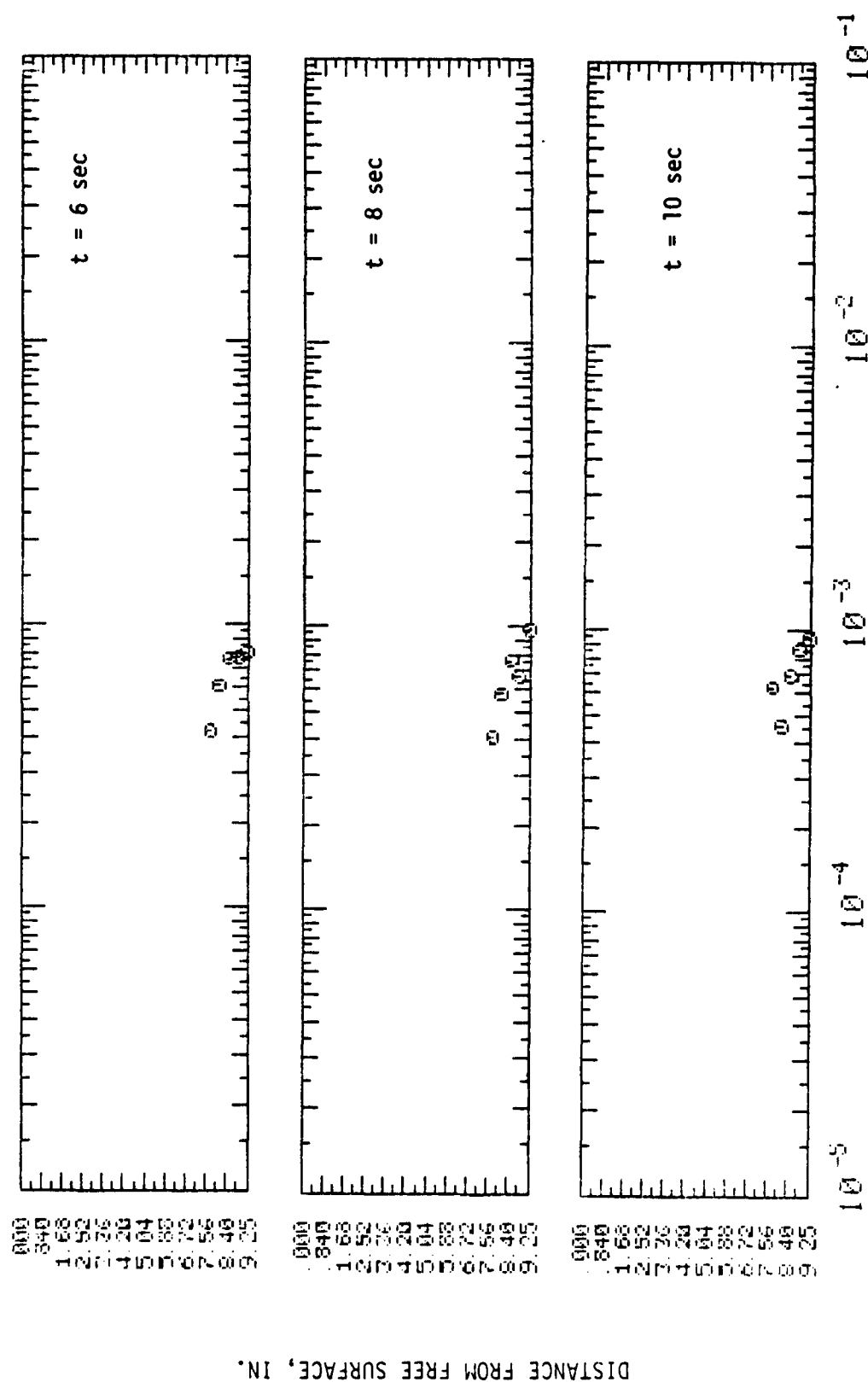
FIGURE G-13. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0

FIGURE G-14. RUN II.1-13 VERTICAL CONCENTRATION PROFILES

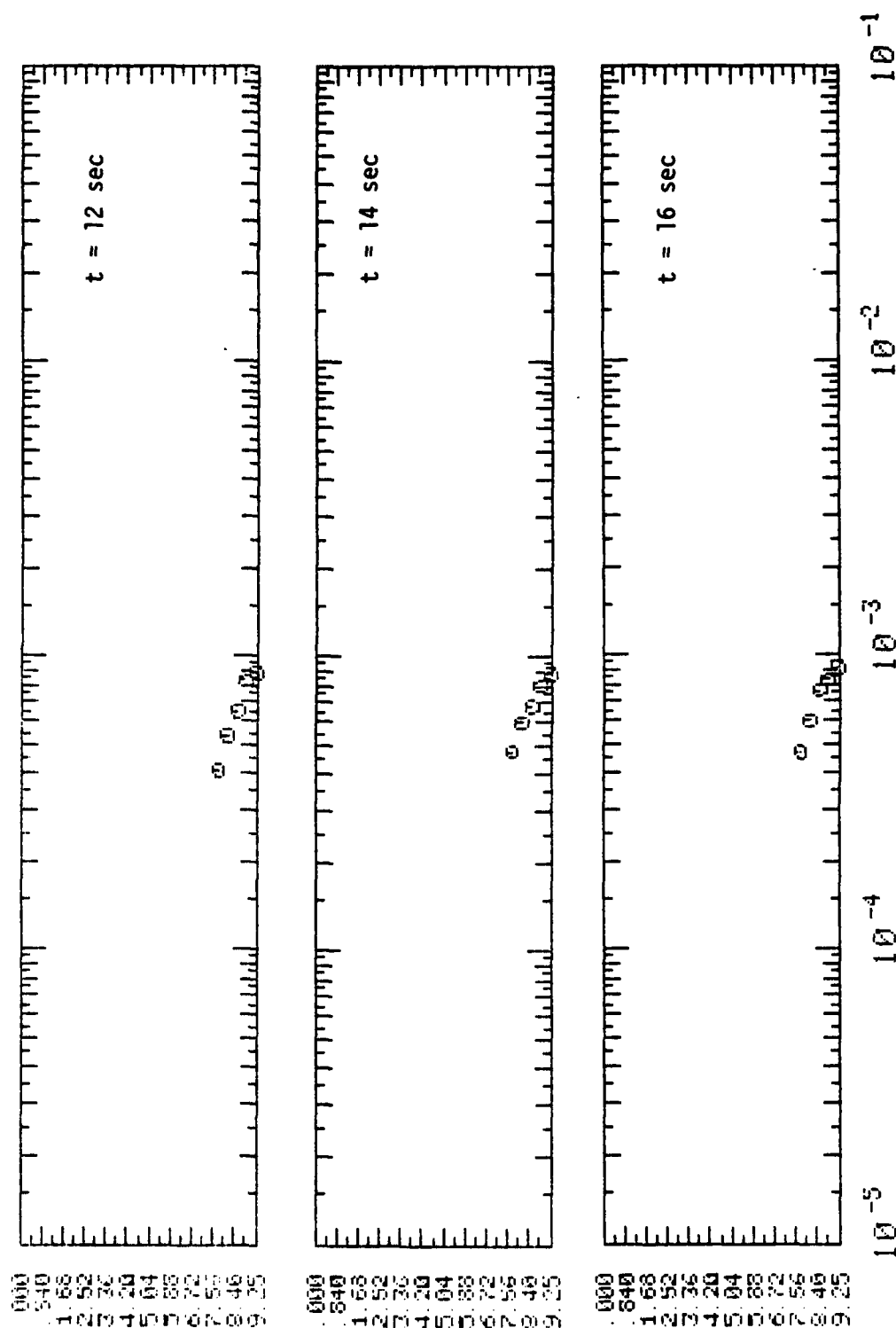


C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE G-15. RUN II.1-13 VERTICAL CONCENTRATION PROFILES

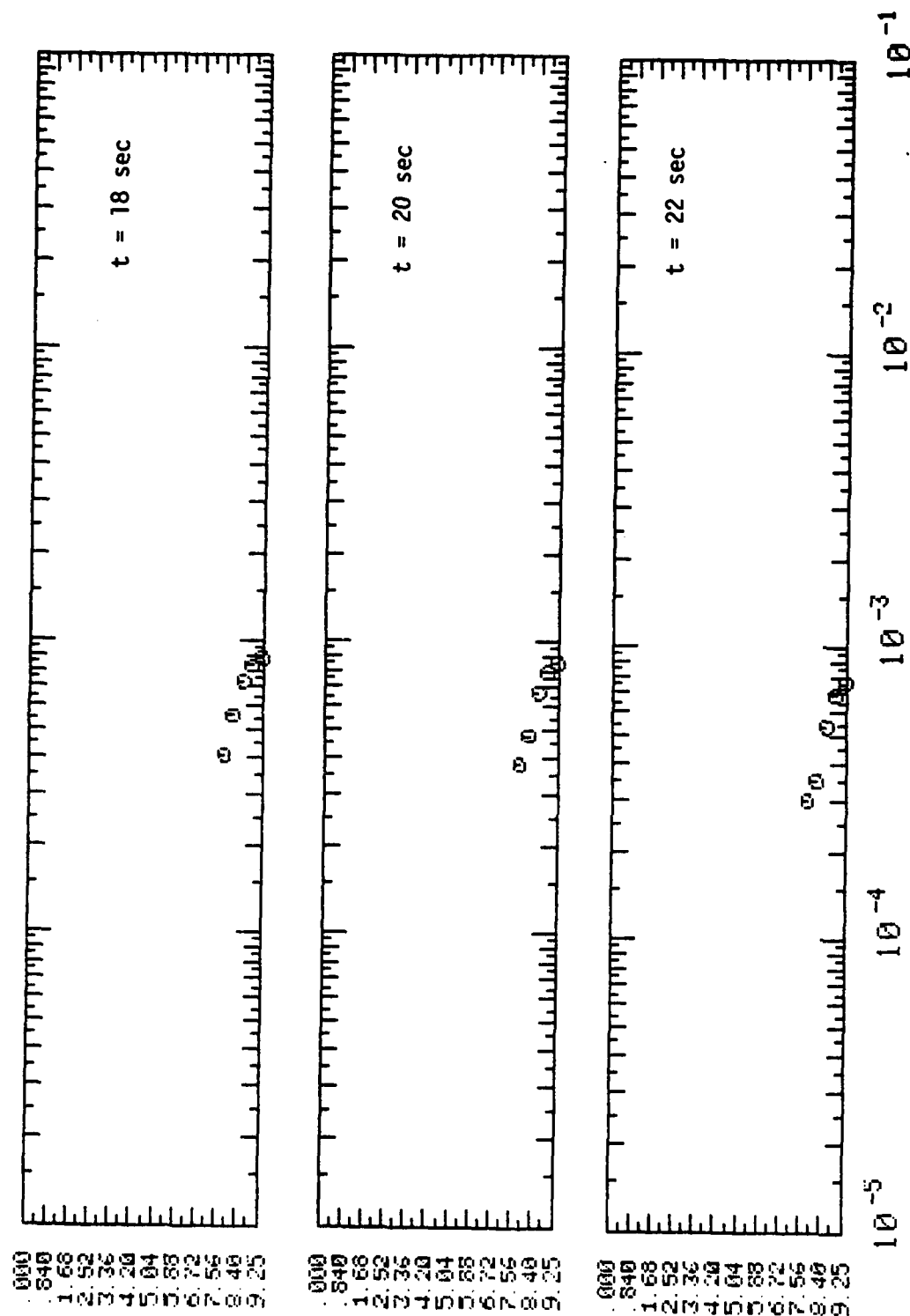
DISTANCE FROM FREE SURFACE, IN.



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0

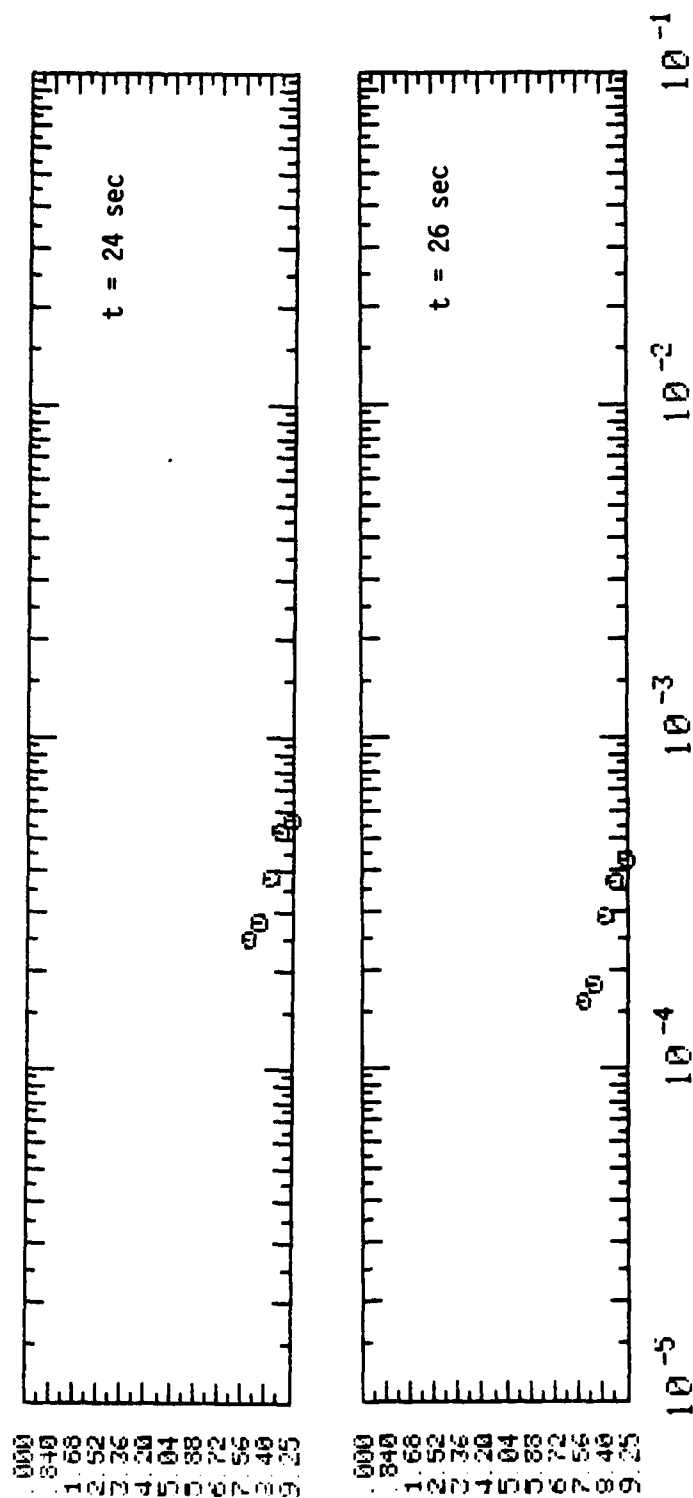
FIGURE G-16. RUN II.1-13 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE G-17. RUN II.1-13 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE 6-18. RUN II.1-13 VERTICAL CONCENTRATION PROFILES

APPENDIX H

CONCENTRATION PROFILES FOR RUN II.1-14

$$\rho_c/\rho = 1.40 \text{ (Sodium Silicate)}$$

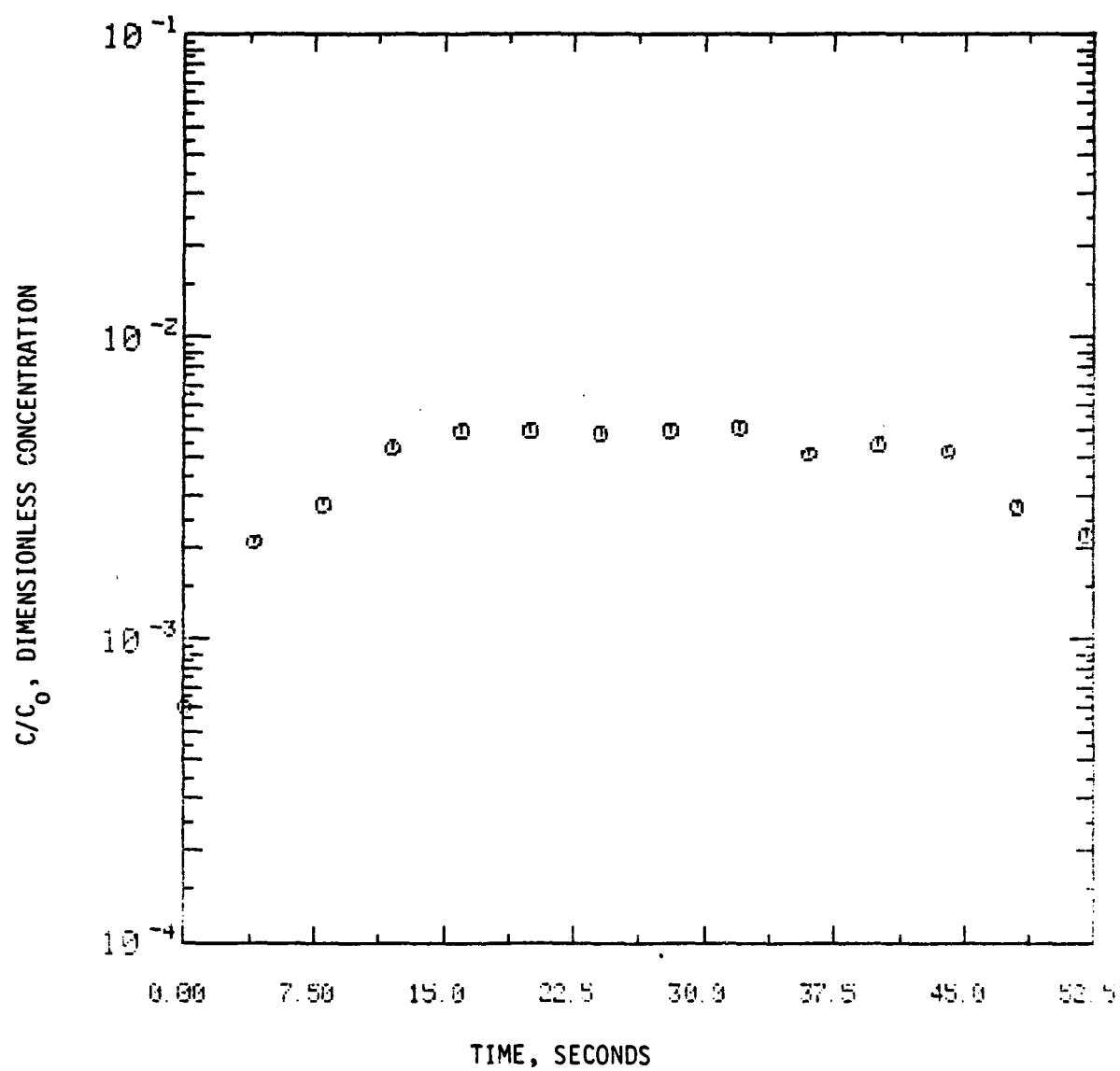
$$r_j/d = 0.23$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	31 sec.
cross stream profiles	31 sec.
vertical profiles	31 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

FIGURE H-1 . RUN II.1-14 CONCENTRATION TIME HISTORY

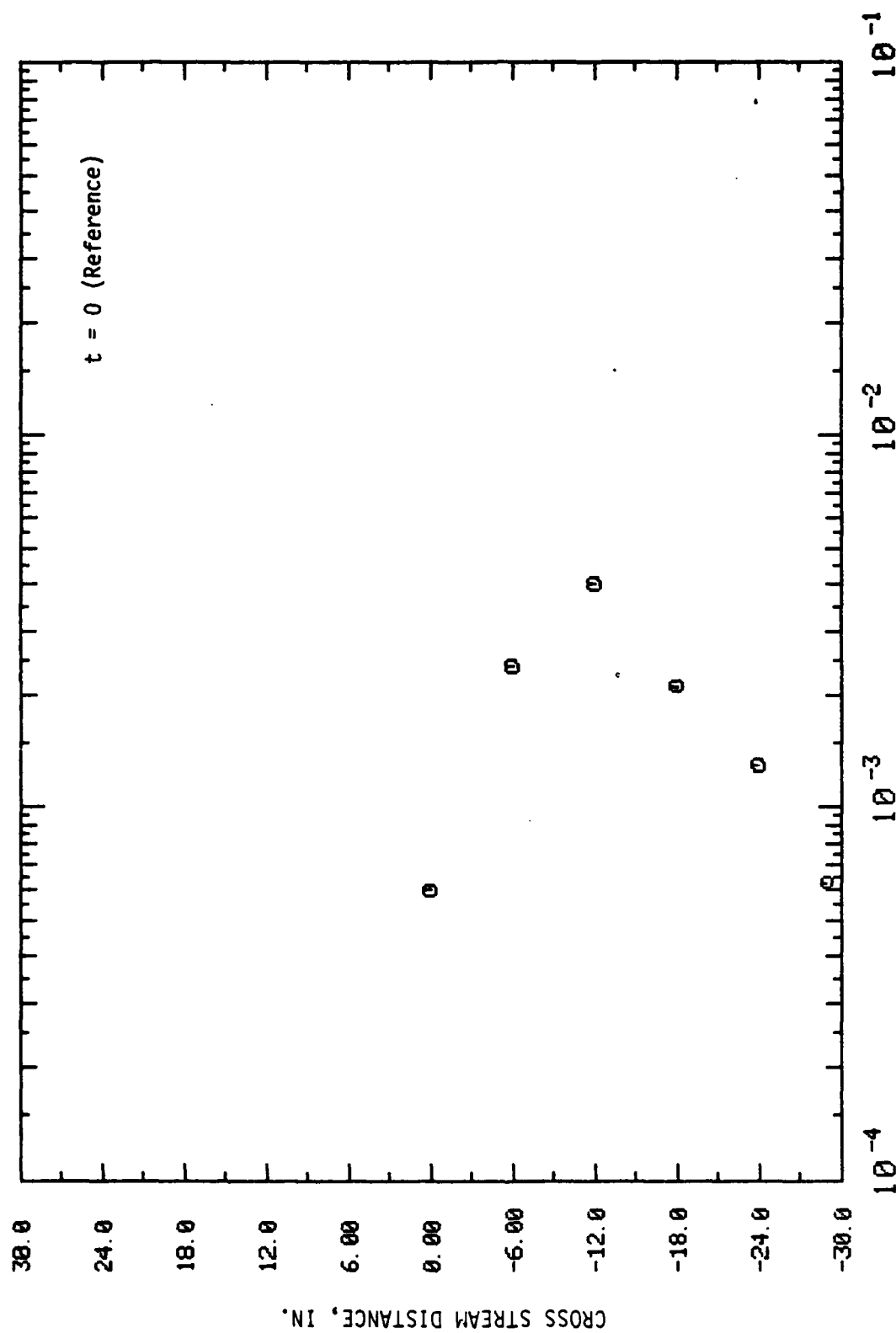


FIGURE H-2 . RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

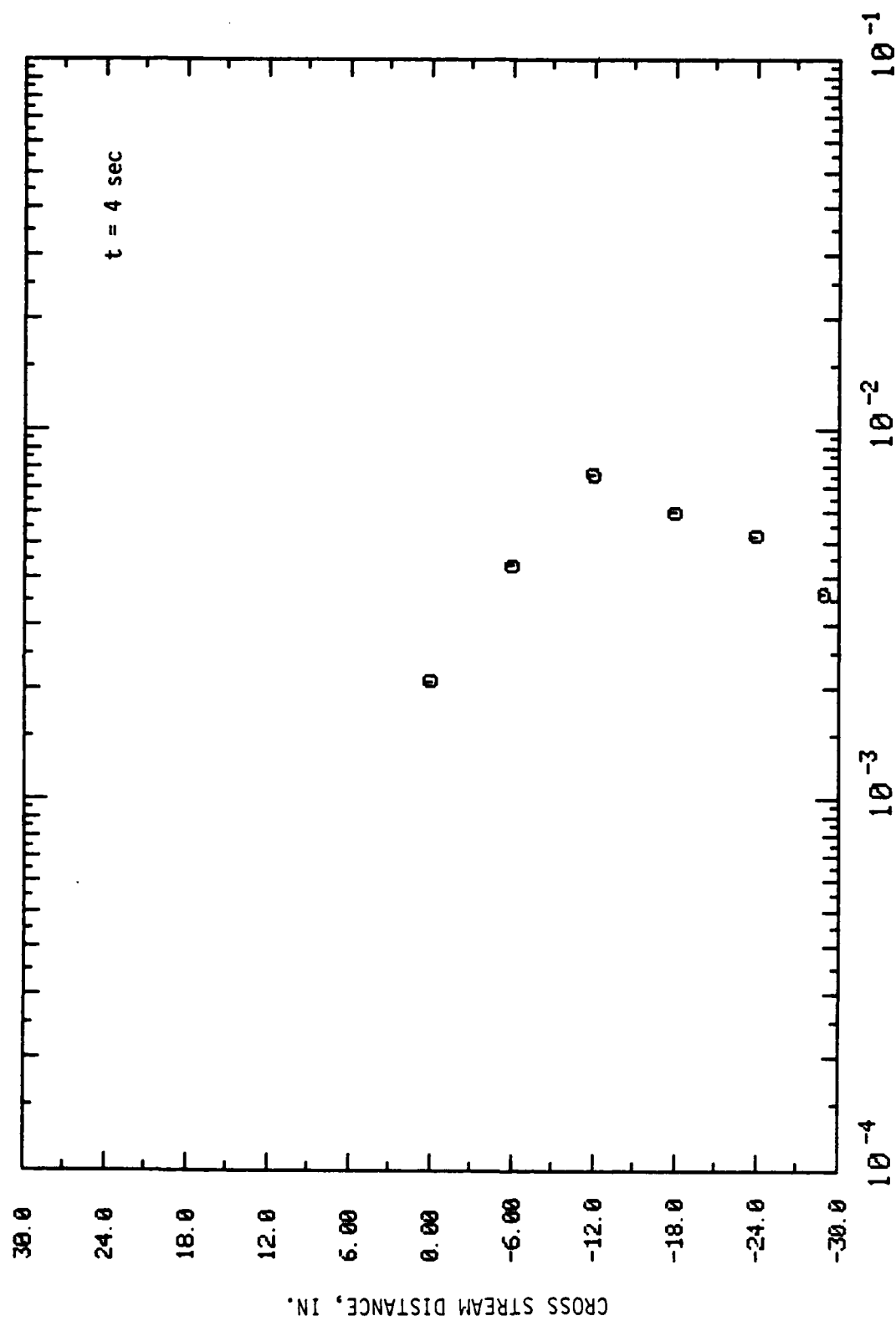
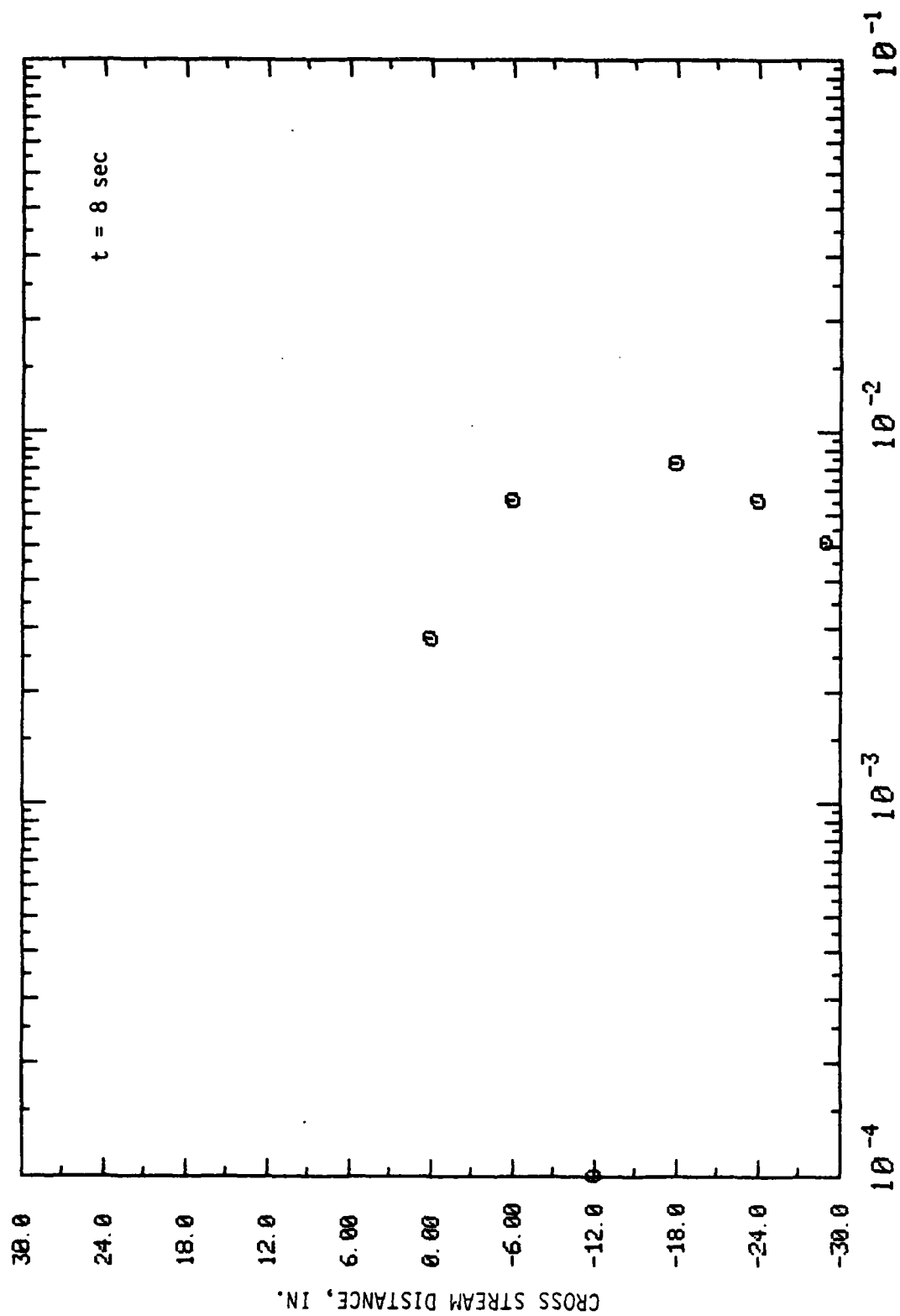


FIGURE H-3. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Z = 9.25 IN.

FIGURE H-4 . RUN II.1.1-14 CROSS STREAM CONCENTRATION PROFILE

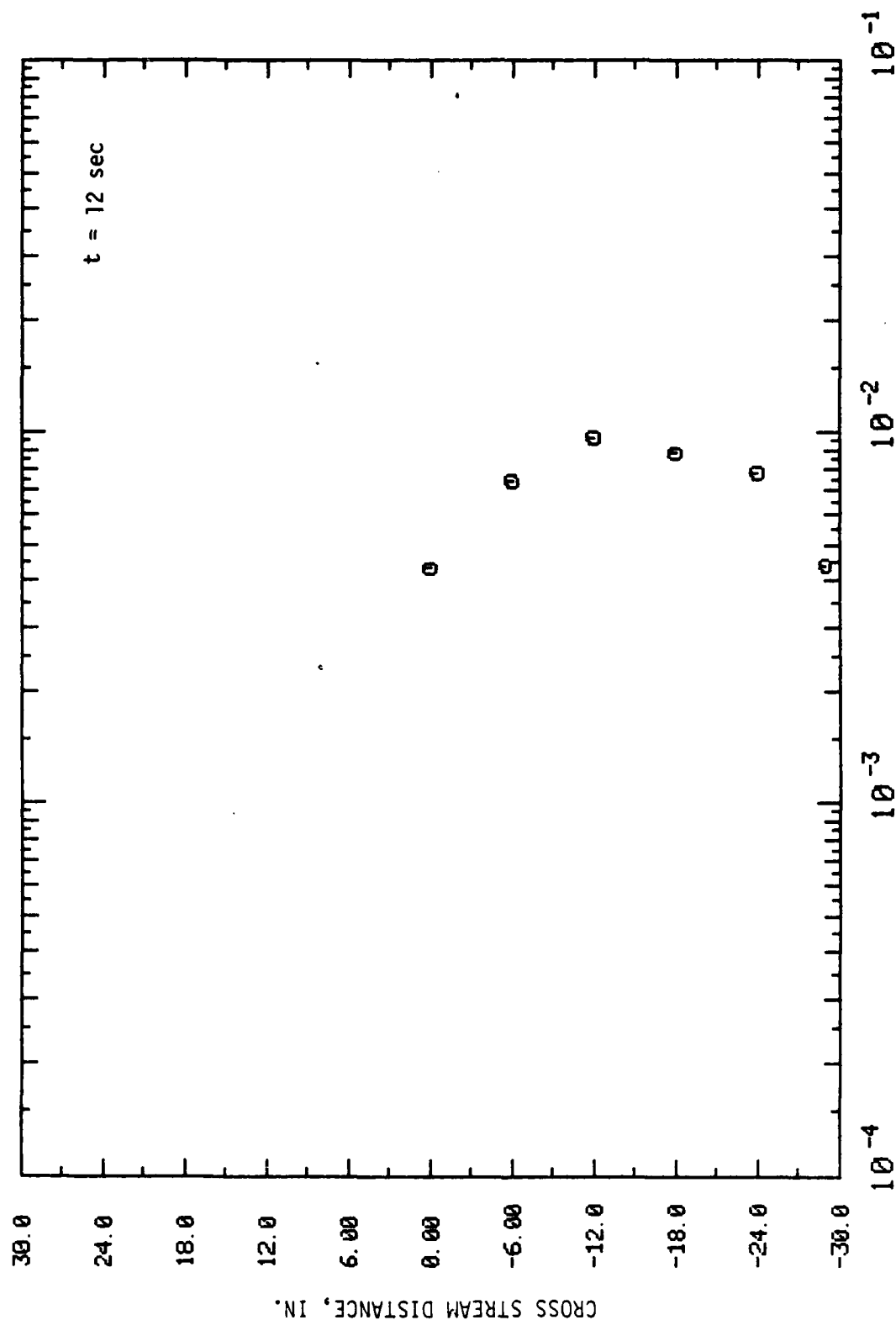


FIGURE H-5 . RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

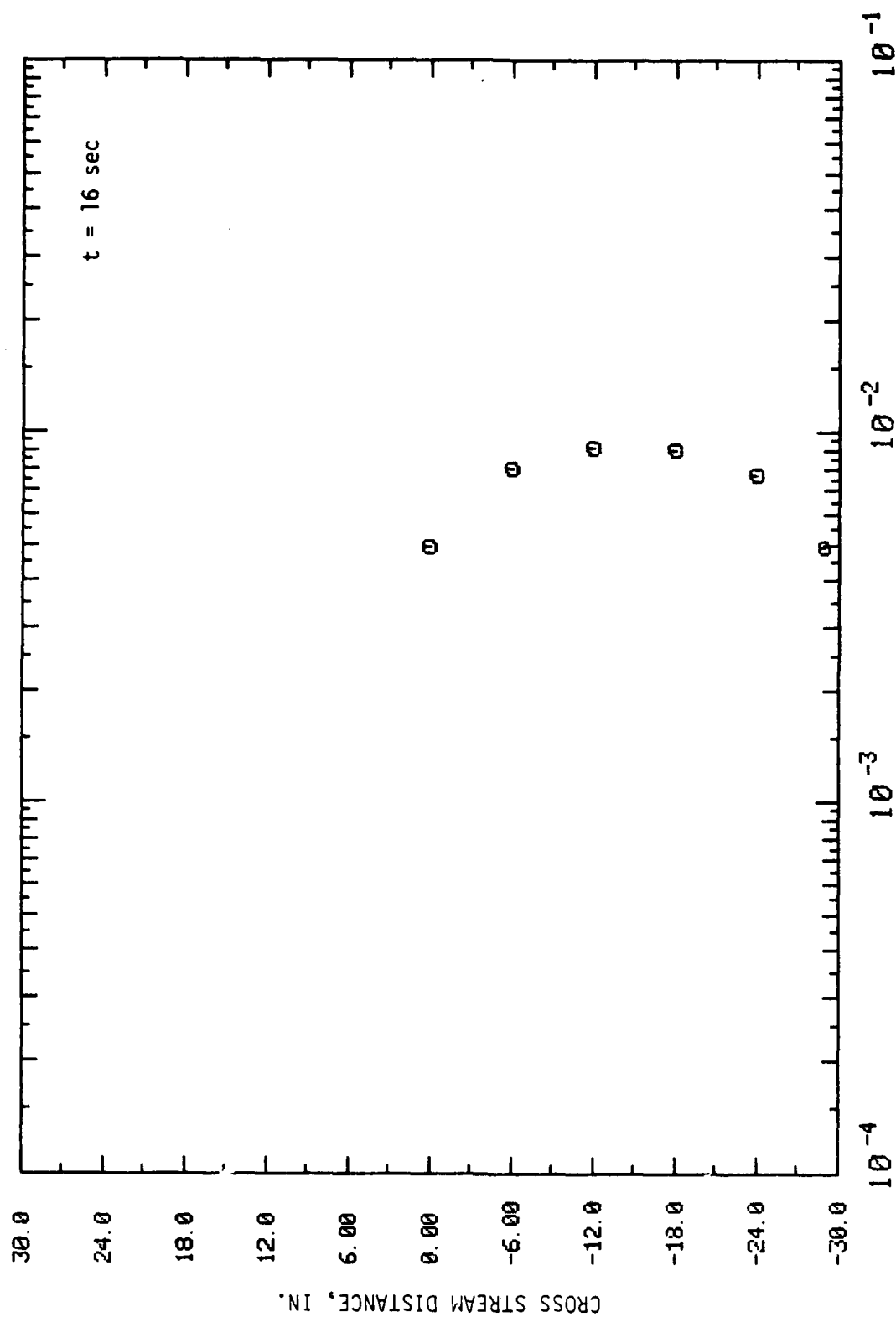


FIGURE H-6. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

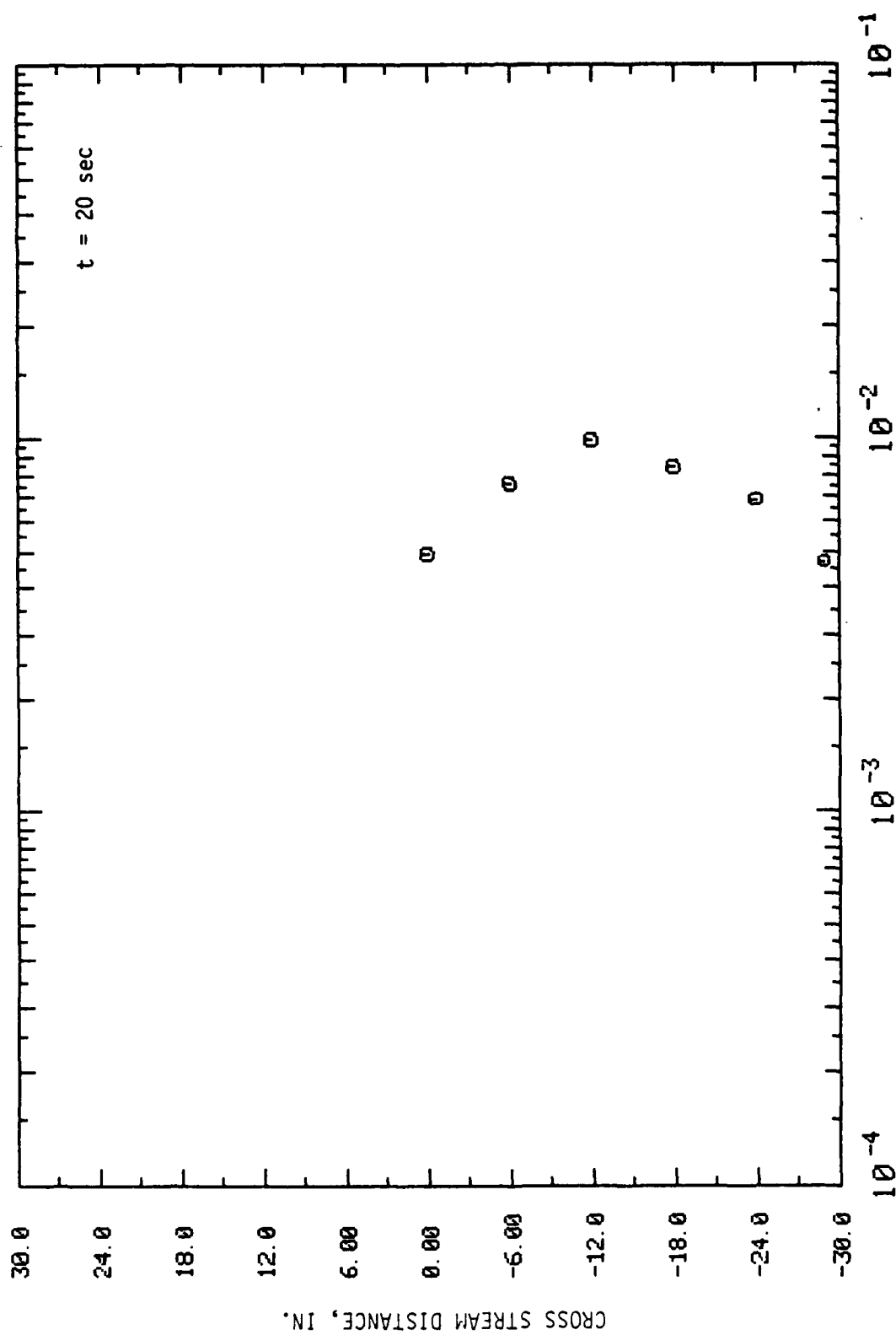
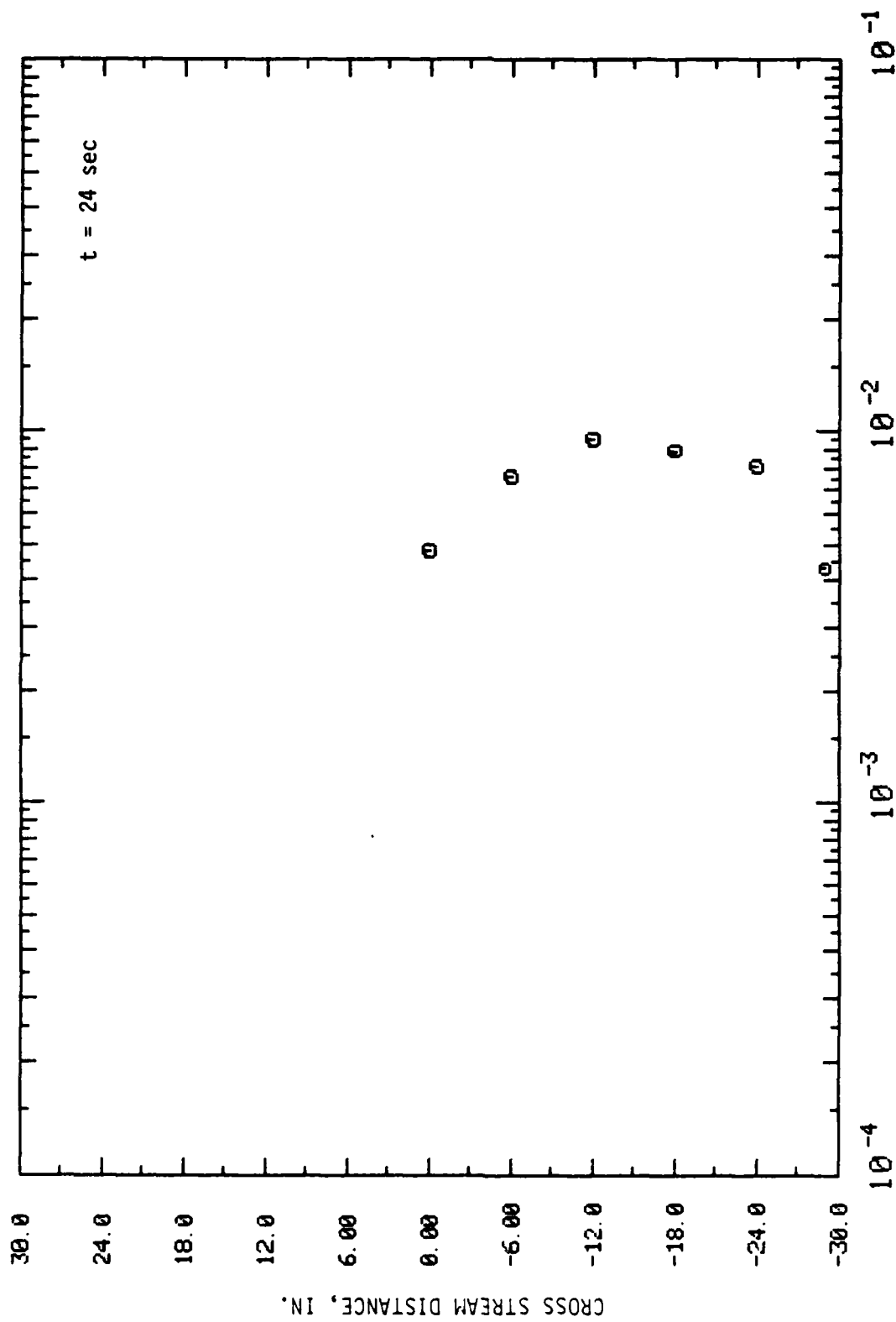


FIGURE H-7. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE H-8. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

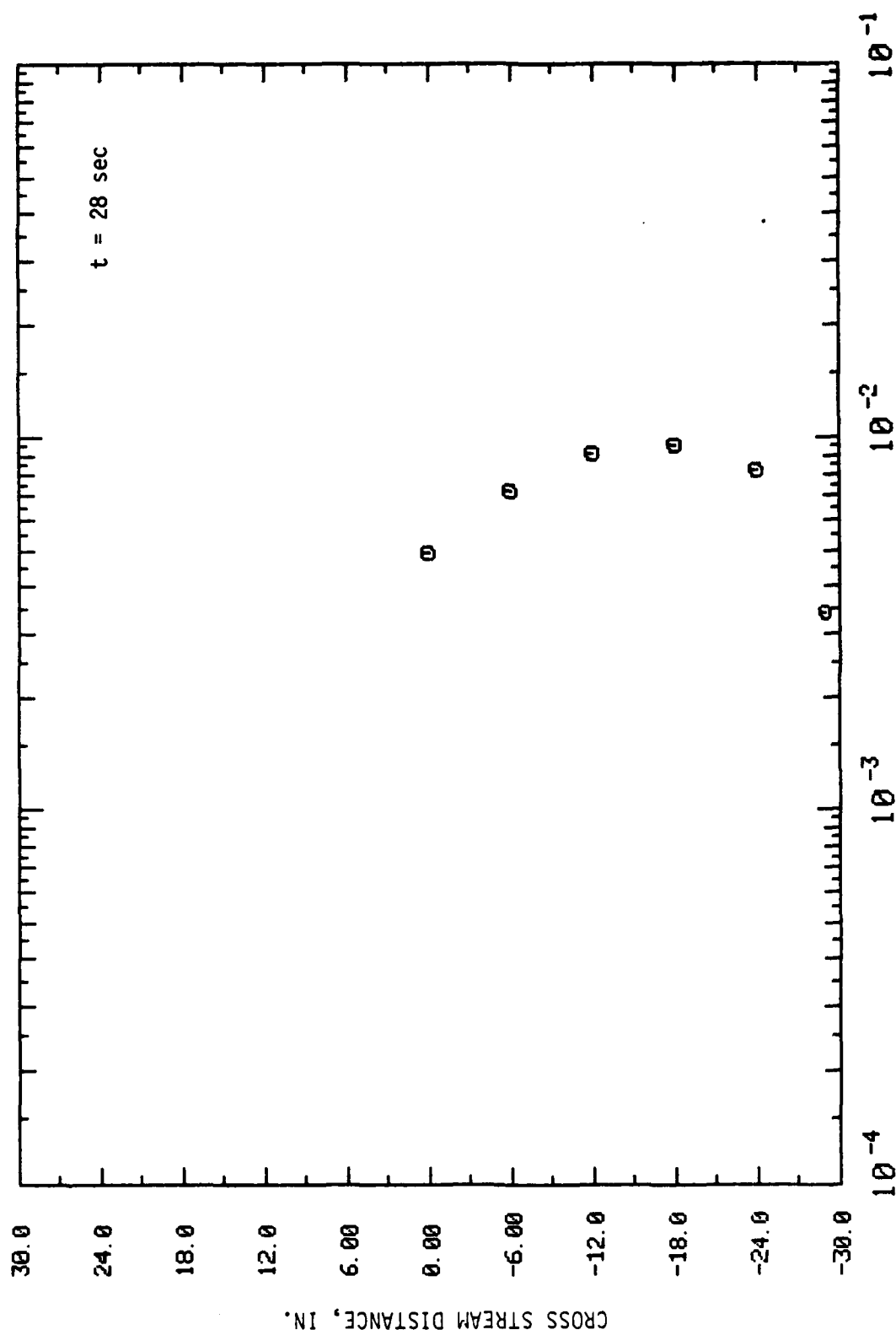


FIGURE H-9. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

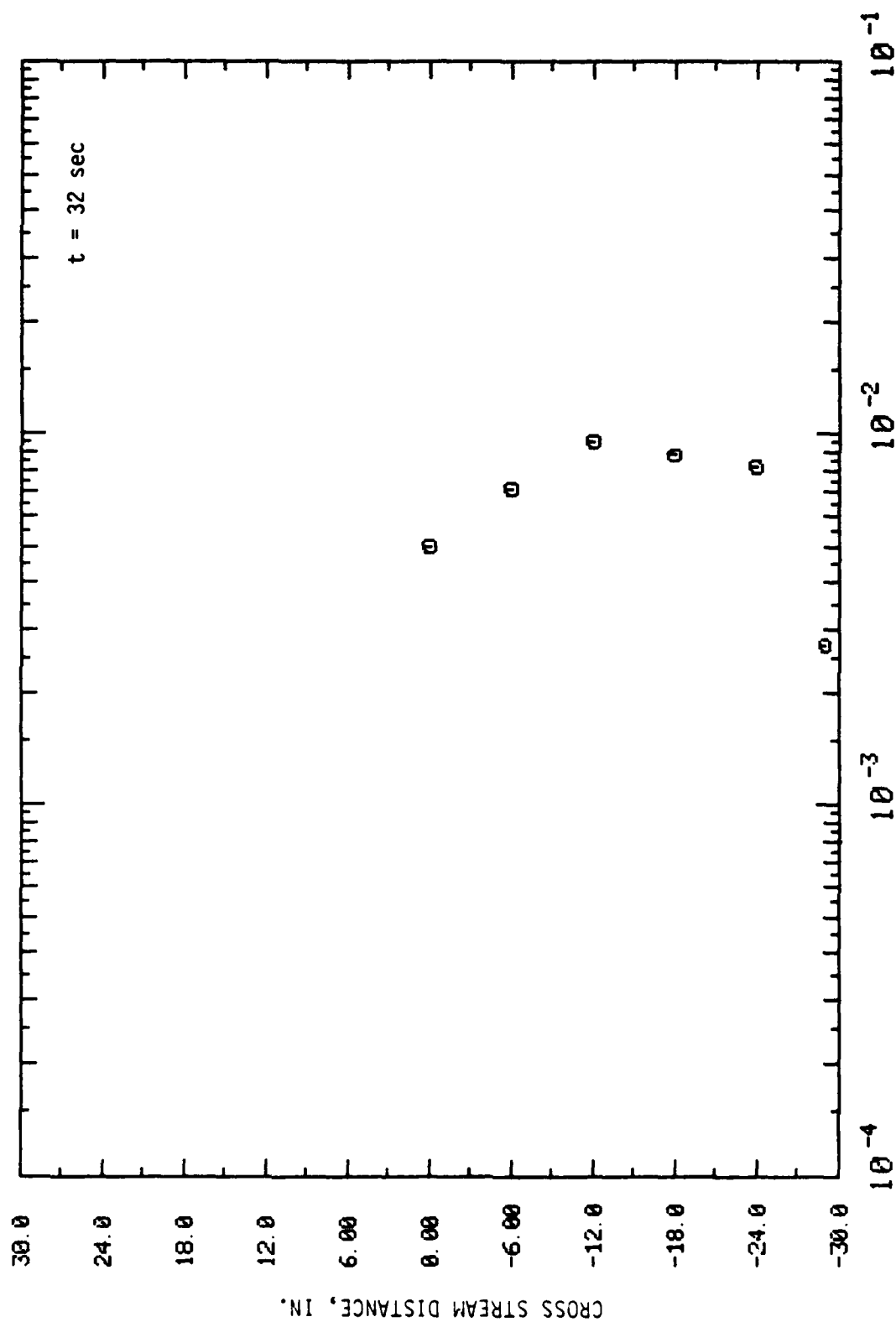


FIGURE H-10. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

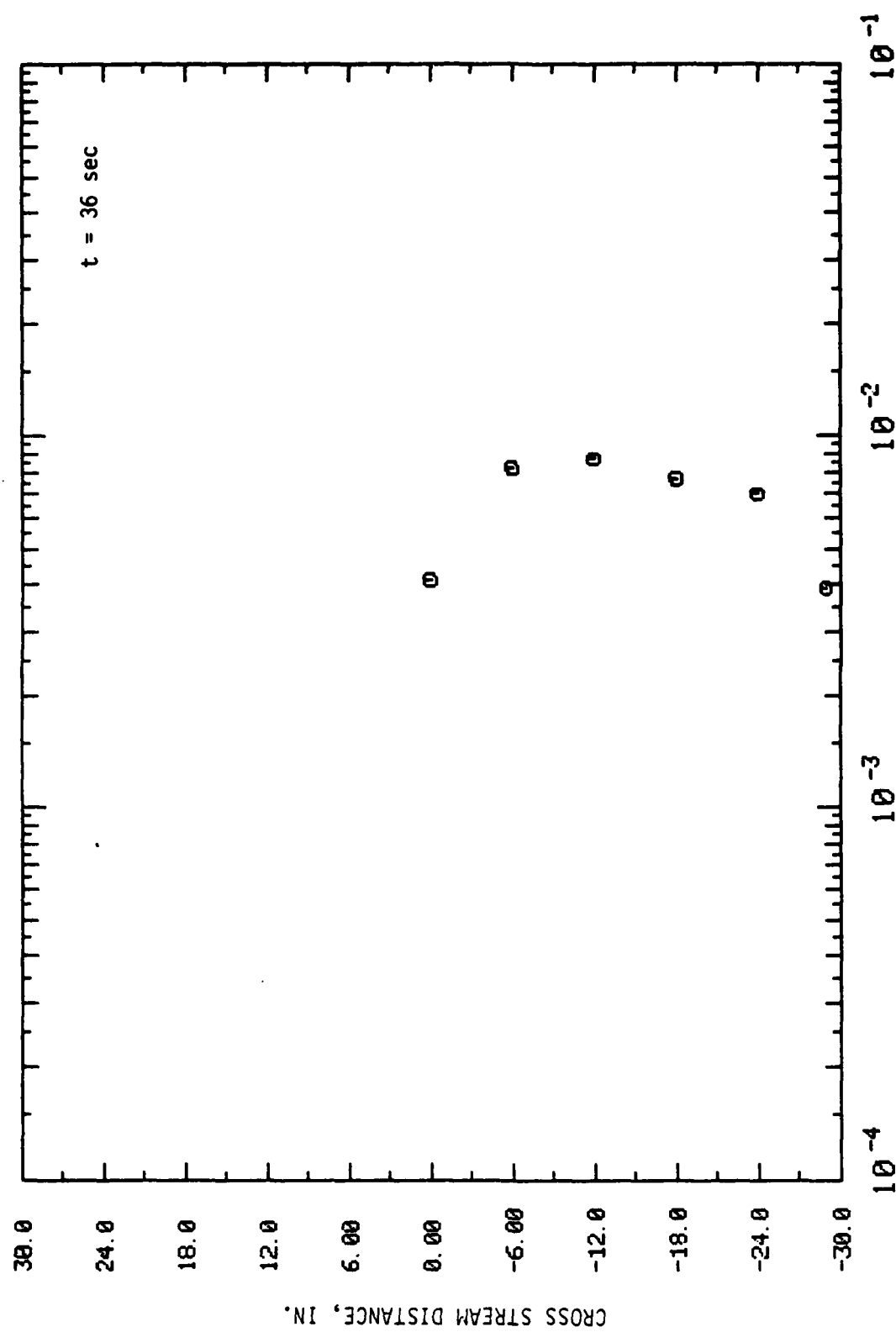


FIGURE H-11. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

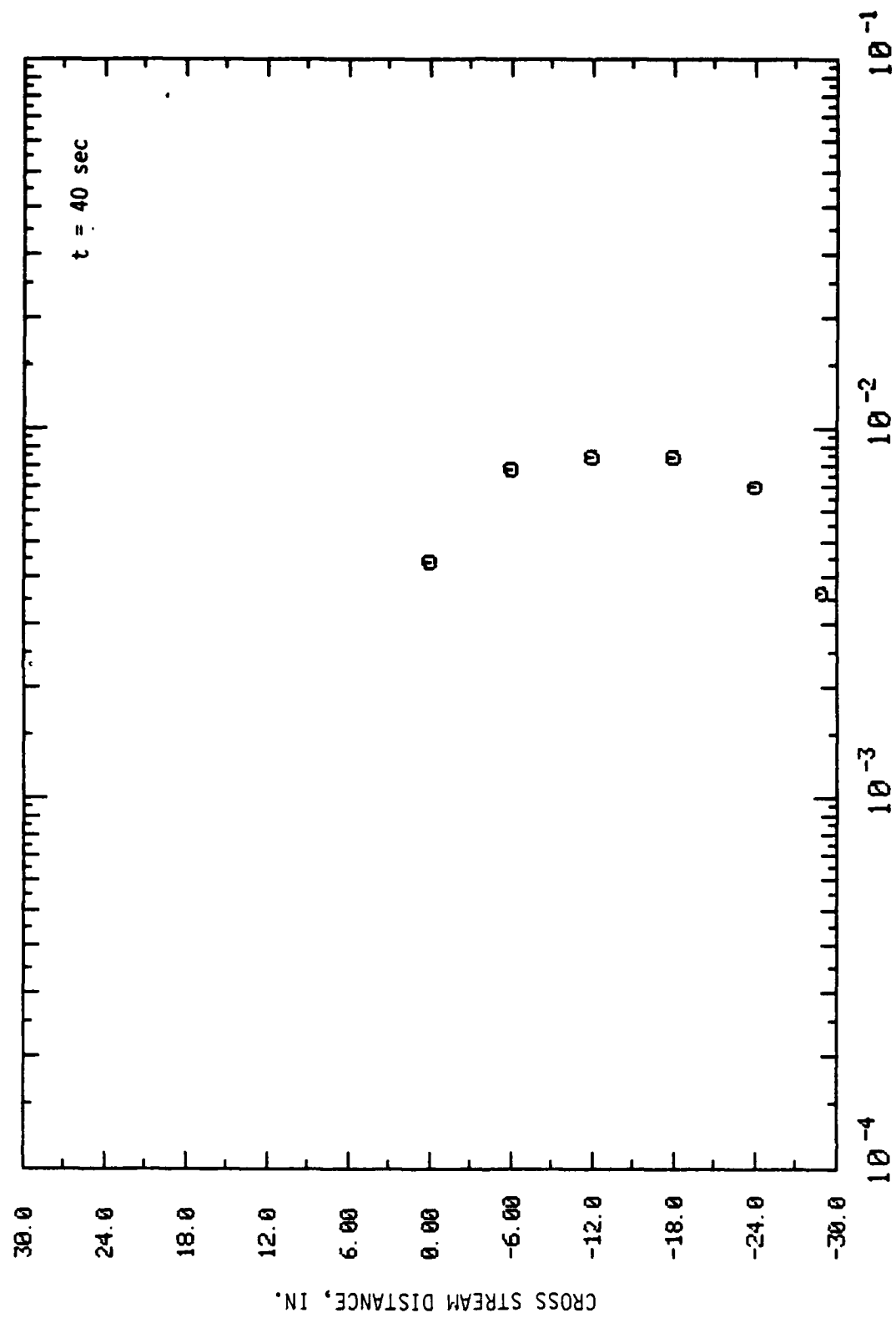
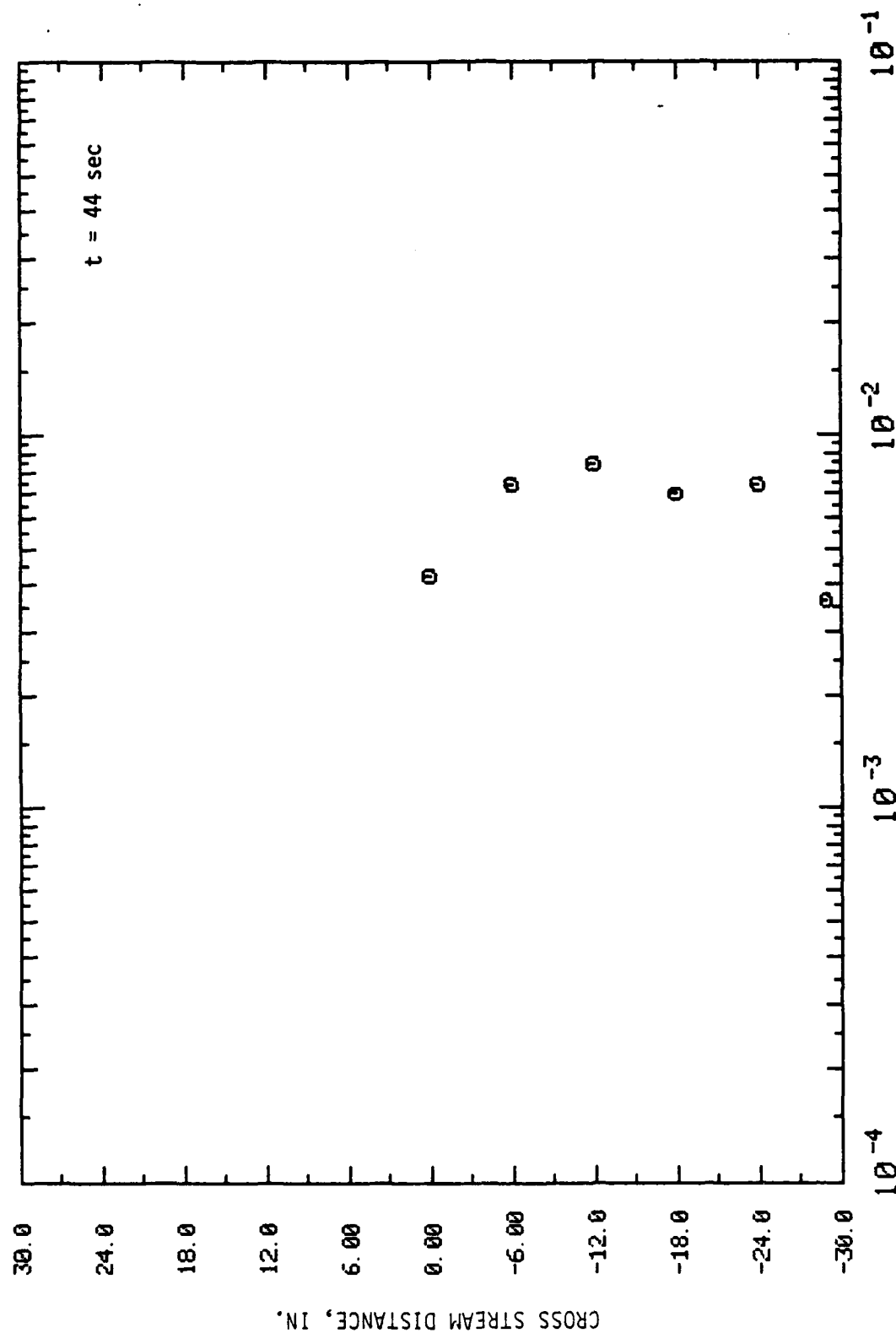


FIGURE H-12. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE H-13. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

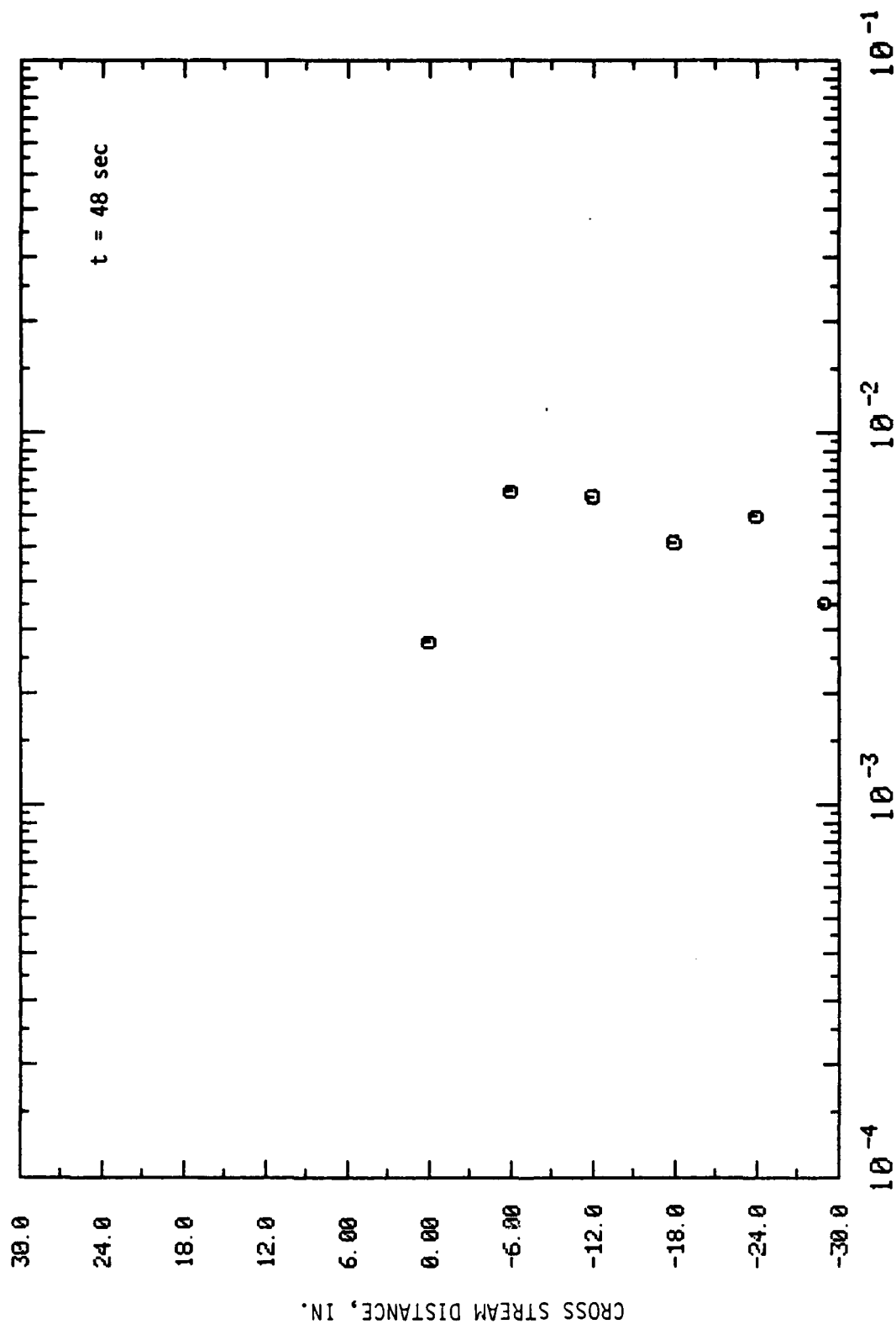
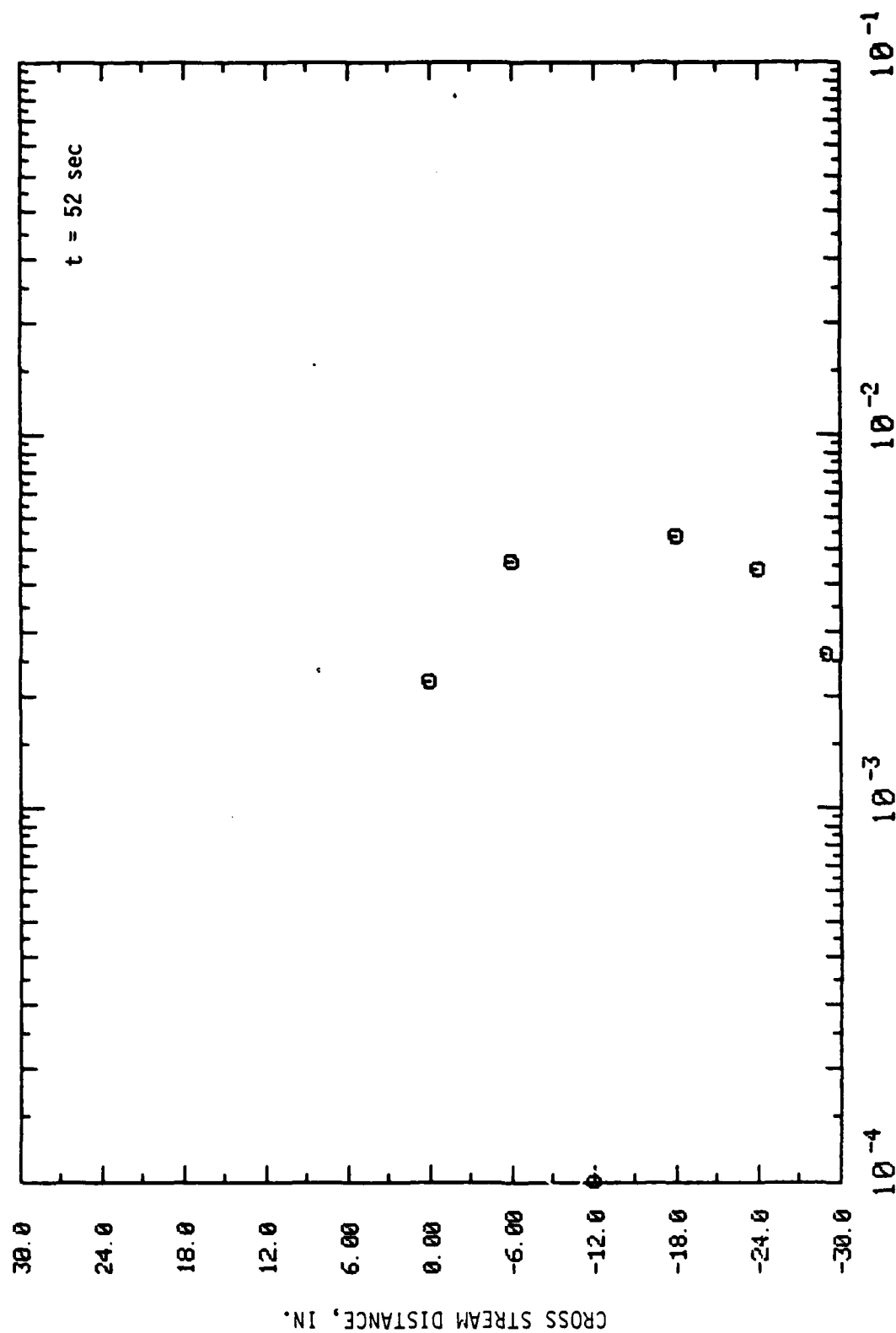


FIGURE H-14. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Z = 9.25 IN.

FIGURE H-15. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

DISTANCE FROM FREE SURFACE, IN.

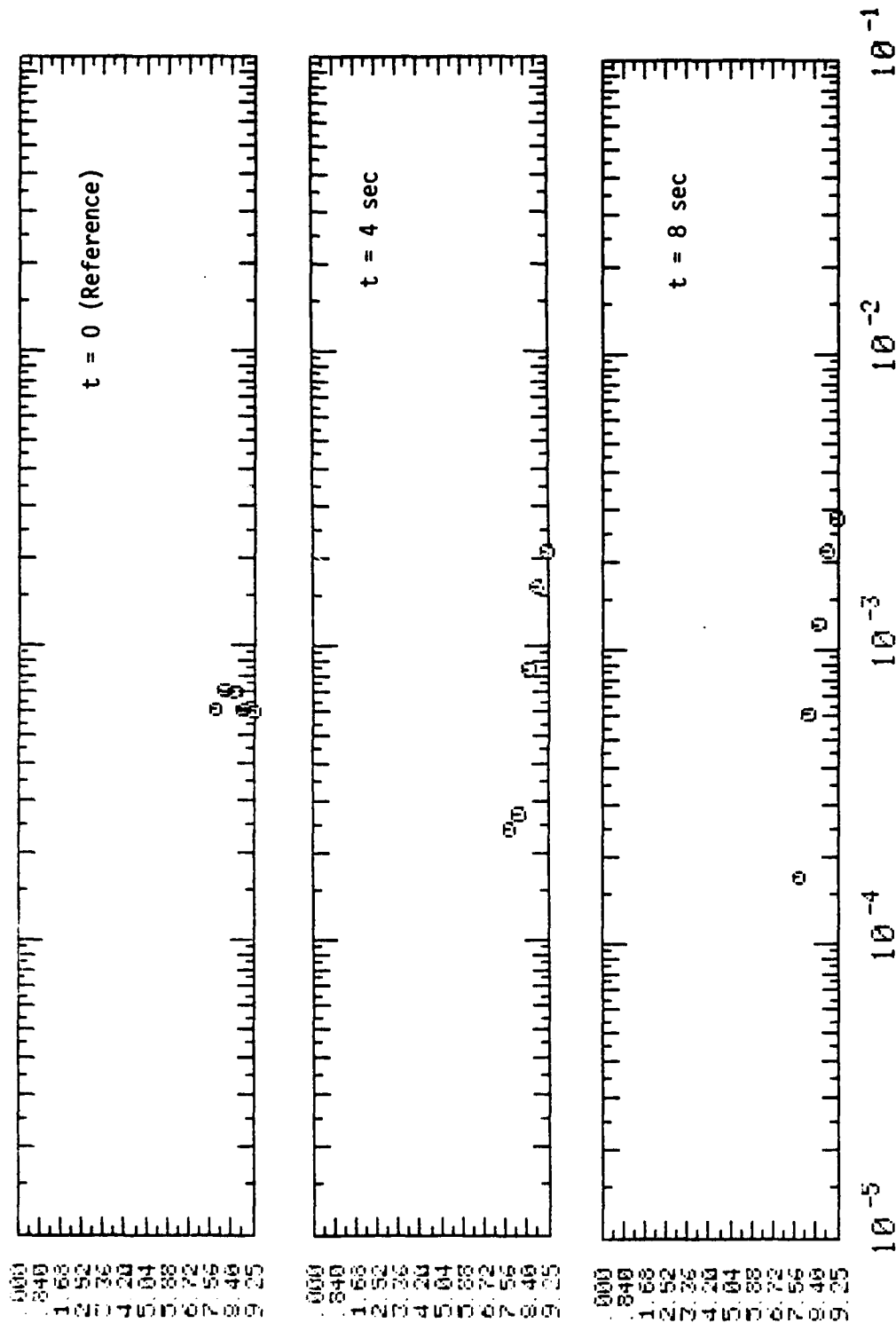
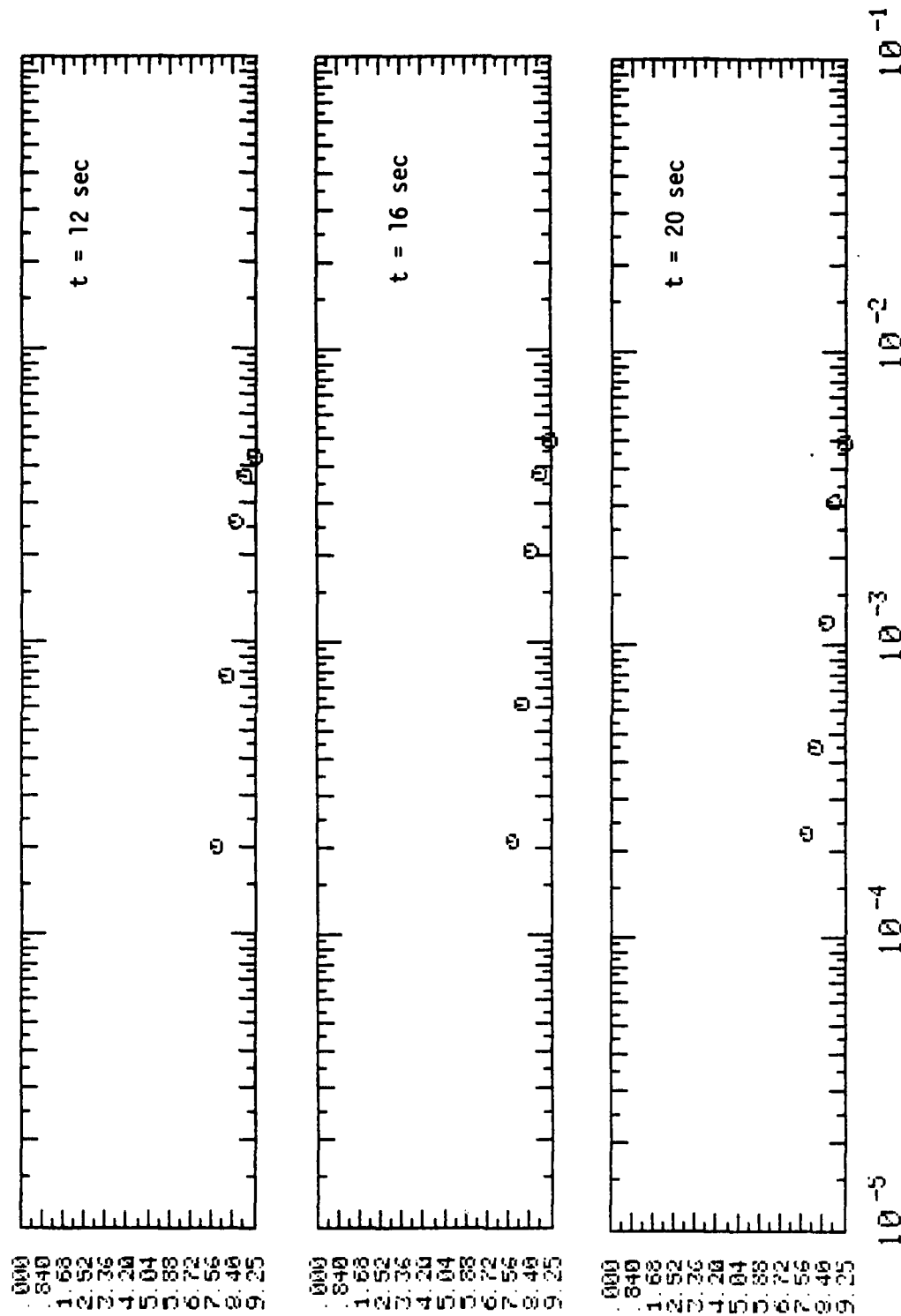
 C/C_0 , DIMENSIONLESS CONCENTRATION $X = 168$ IN., $Y = 0$

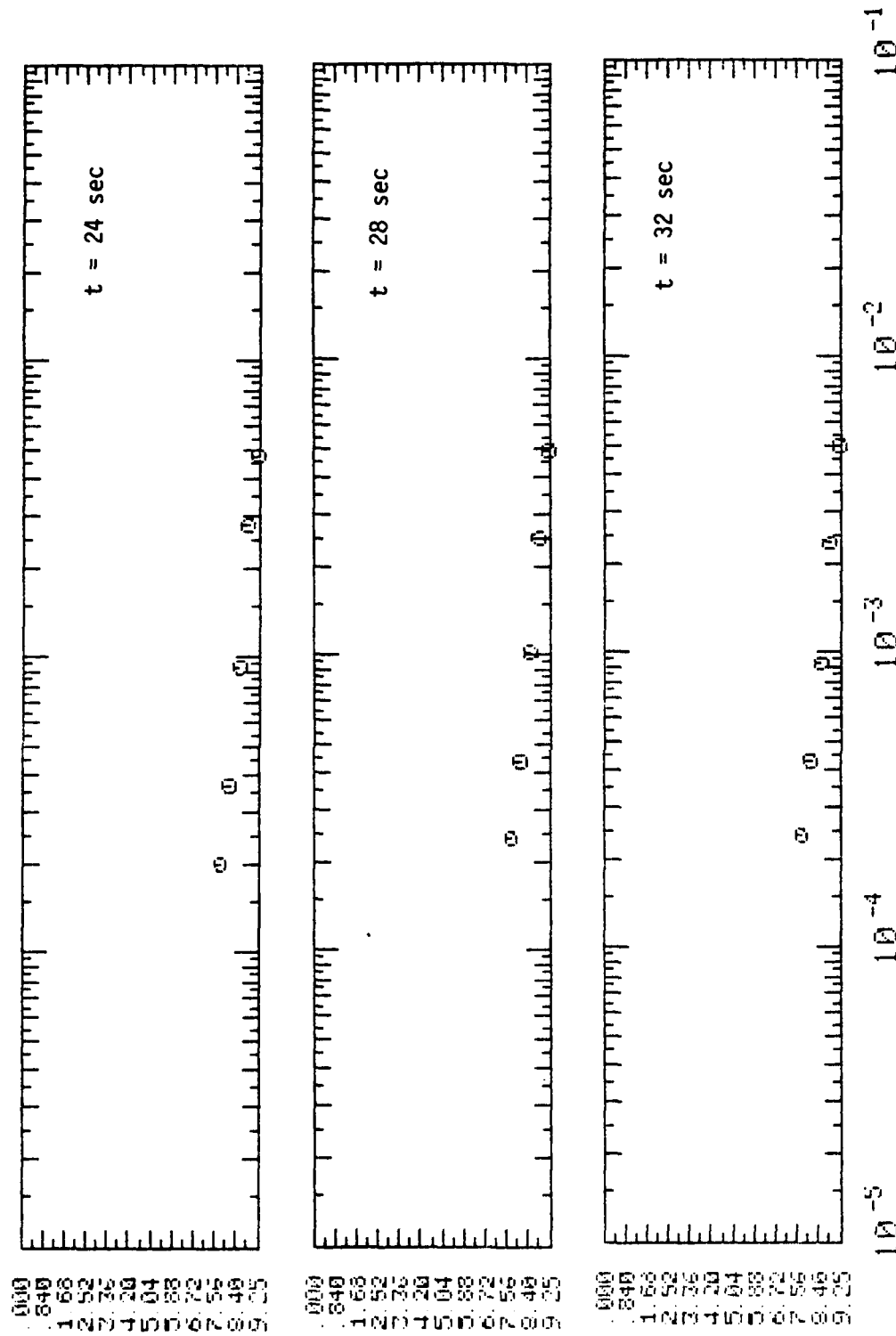
FIGURE H-16. RUN II.1-14 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0

FIGURE H-17. RUN II.1-14 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE H-18. RUN II.1-14 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

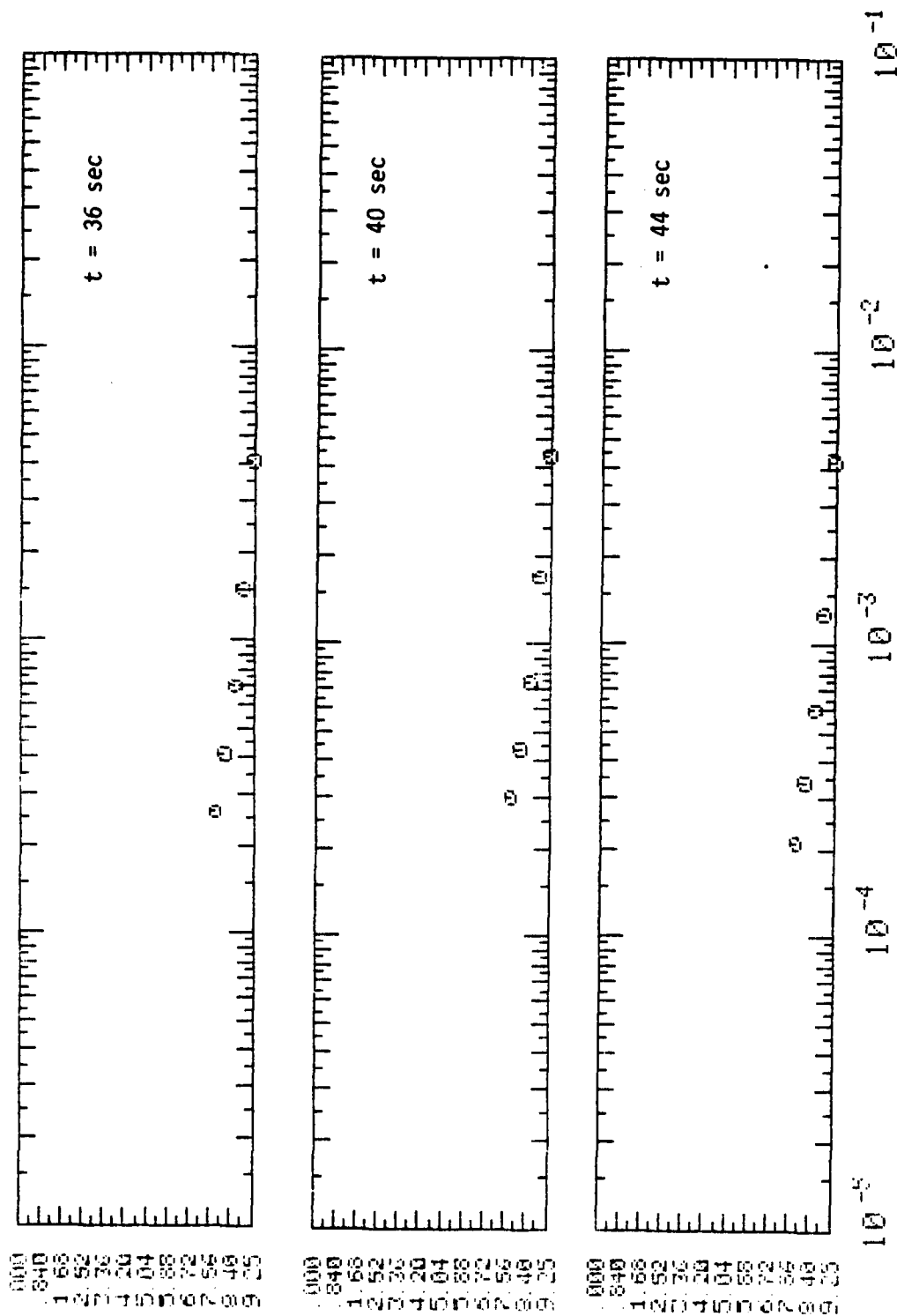
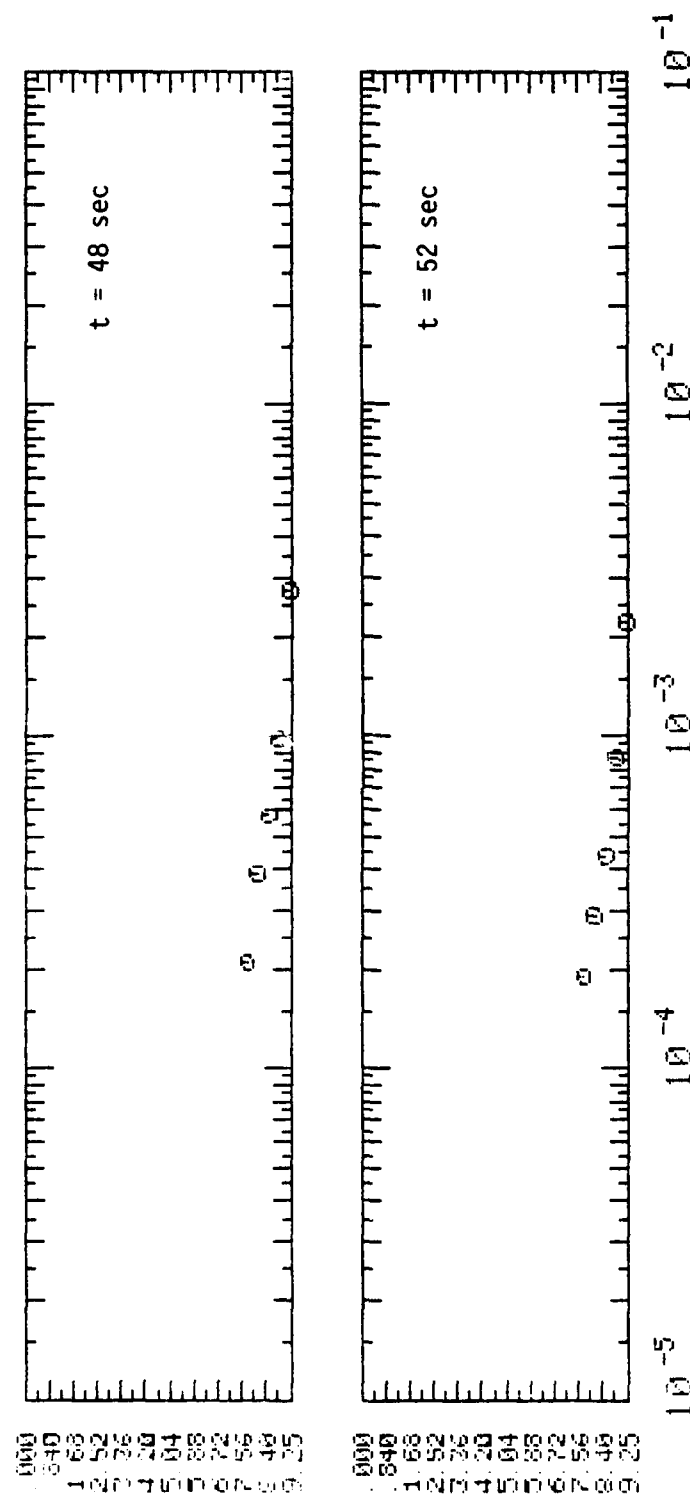
 C/C_0 , DIMENSIONLESS CONCENTRATION $X = 168$ IN., $Y = 0$

FIGURE H-19. RUN II.1-14 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Y = 0$

FIGURE H-20. RUN II.1-14 VERTICAL CONCENTRATION PROFILES

APPENDIX I

CONCENTRATION PROFILES FOR RUN II.1-19

$$\rho_c/\rho = 1.00 \text{ (Water)}$$

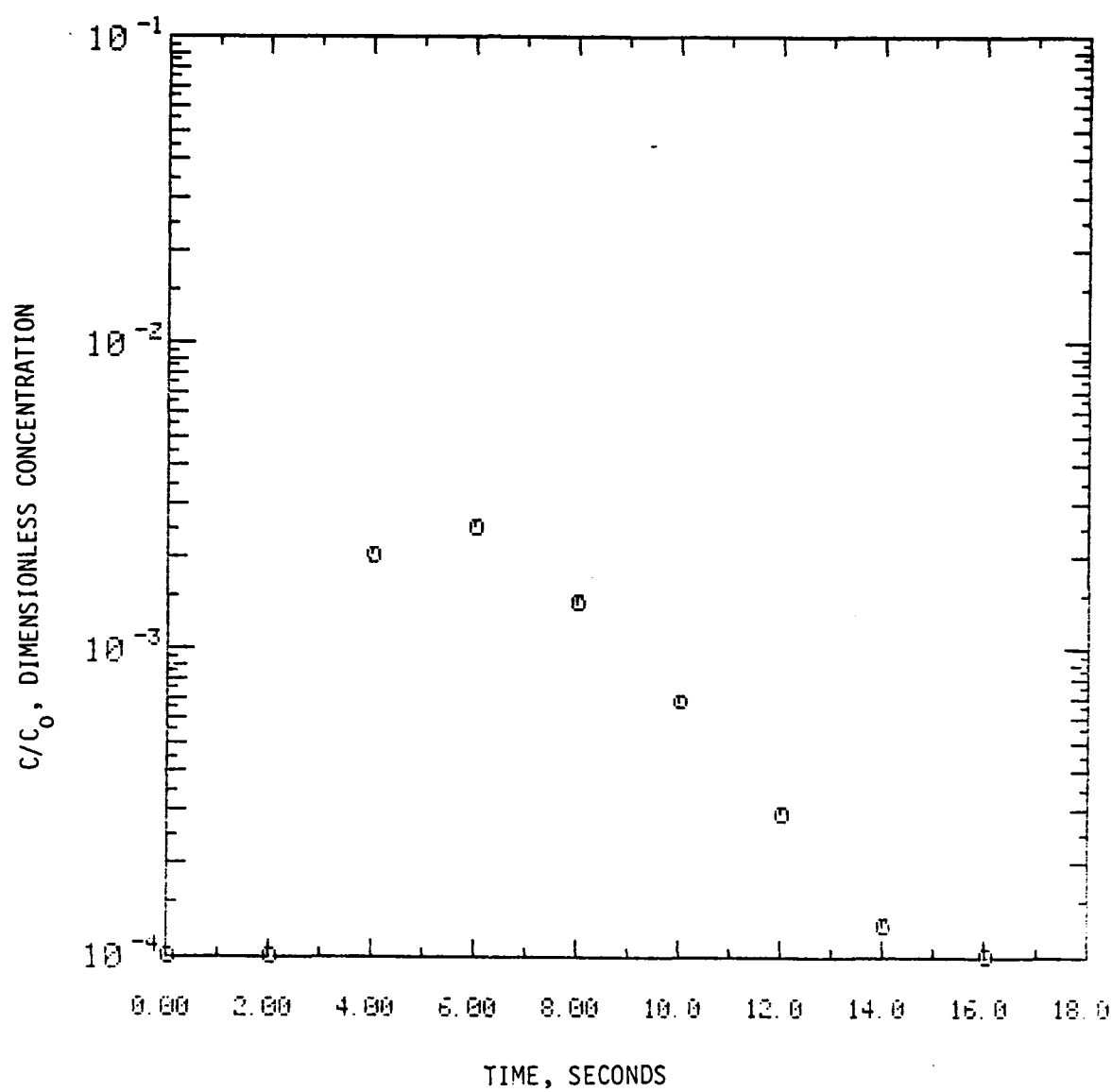
$$r_i/d = 0.125$$

$$u_t/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	27 sec.
vertical profiles	31 sec.



X = 168 IN., Y = 0, Z = 1.25 IN.

FIGURE I-1. RUN II.1-19 CONCENTRATION TIME HISTORY

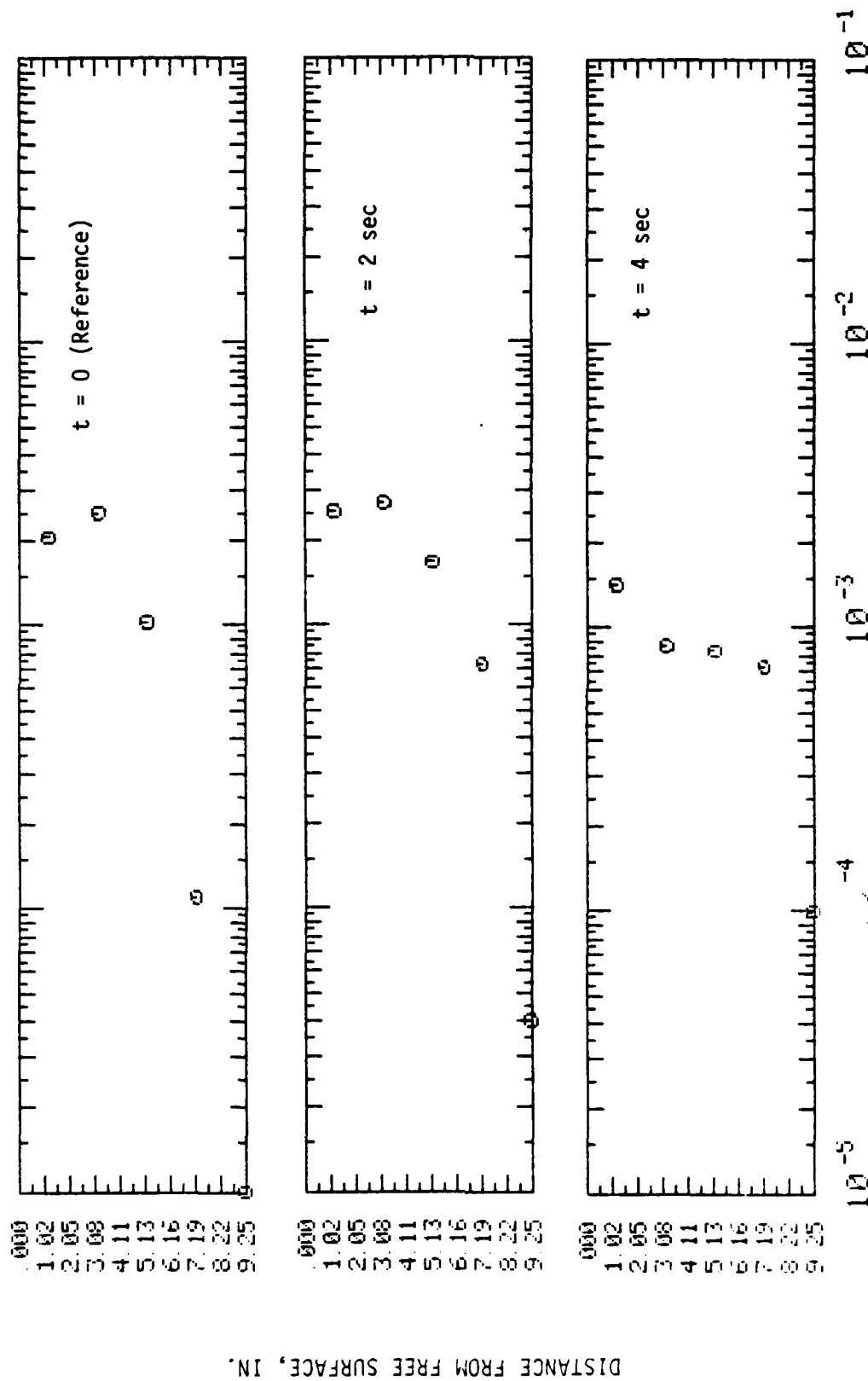
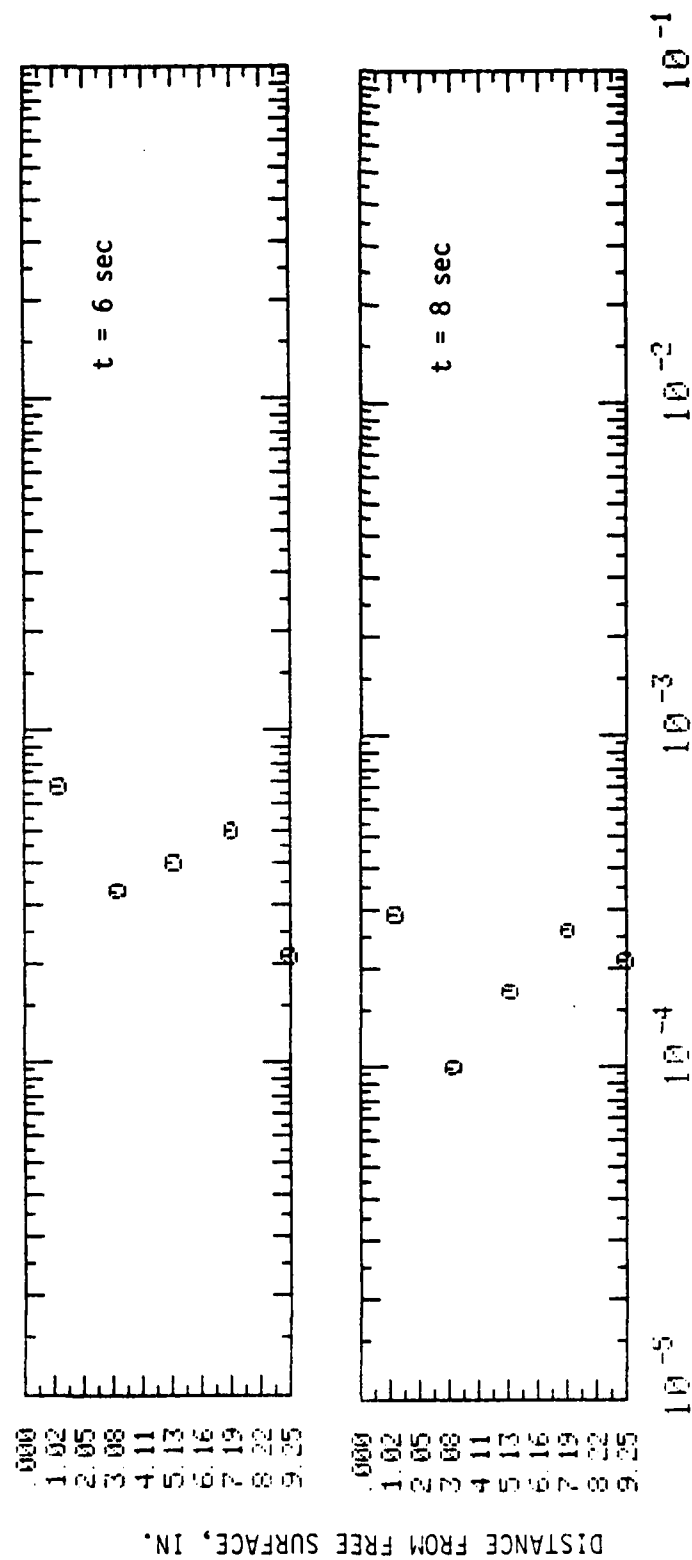


FIGURE I-2. RUN II.1-19 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Y = 0$

FIGURE I-3. RUN II.1-19 VERTICAL CONCENTRATION PROFILES

APPENDIX J

CONCENTRATION PROFILES FOR RUN II.1-20

$$\rho_c/\rho = 1.00 \text{ (Water)}$$

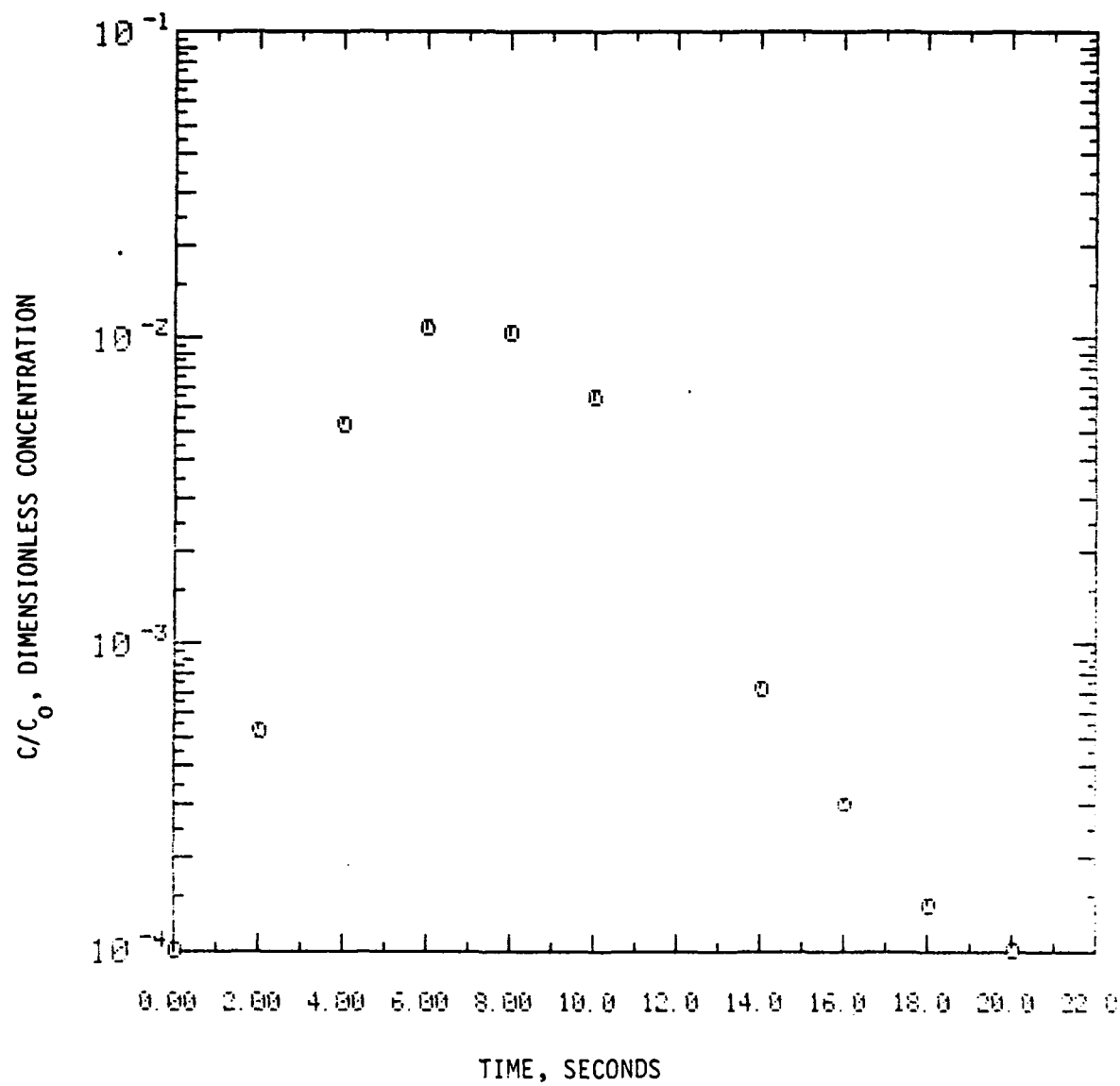
$$r_i/d = 0.23$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	27 sec.
vertical profiles	31 sec.



X = 168 IN., Y = 0, Z = 1.25 IN.

FIGURE J-1. RUN II.1-20 CONCENTRATION TIME HISTORY

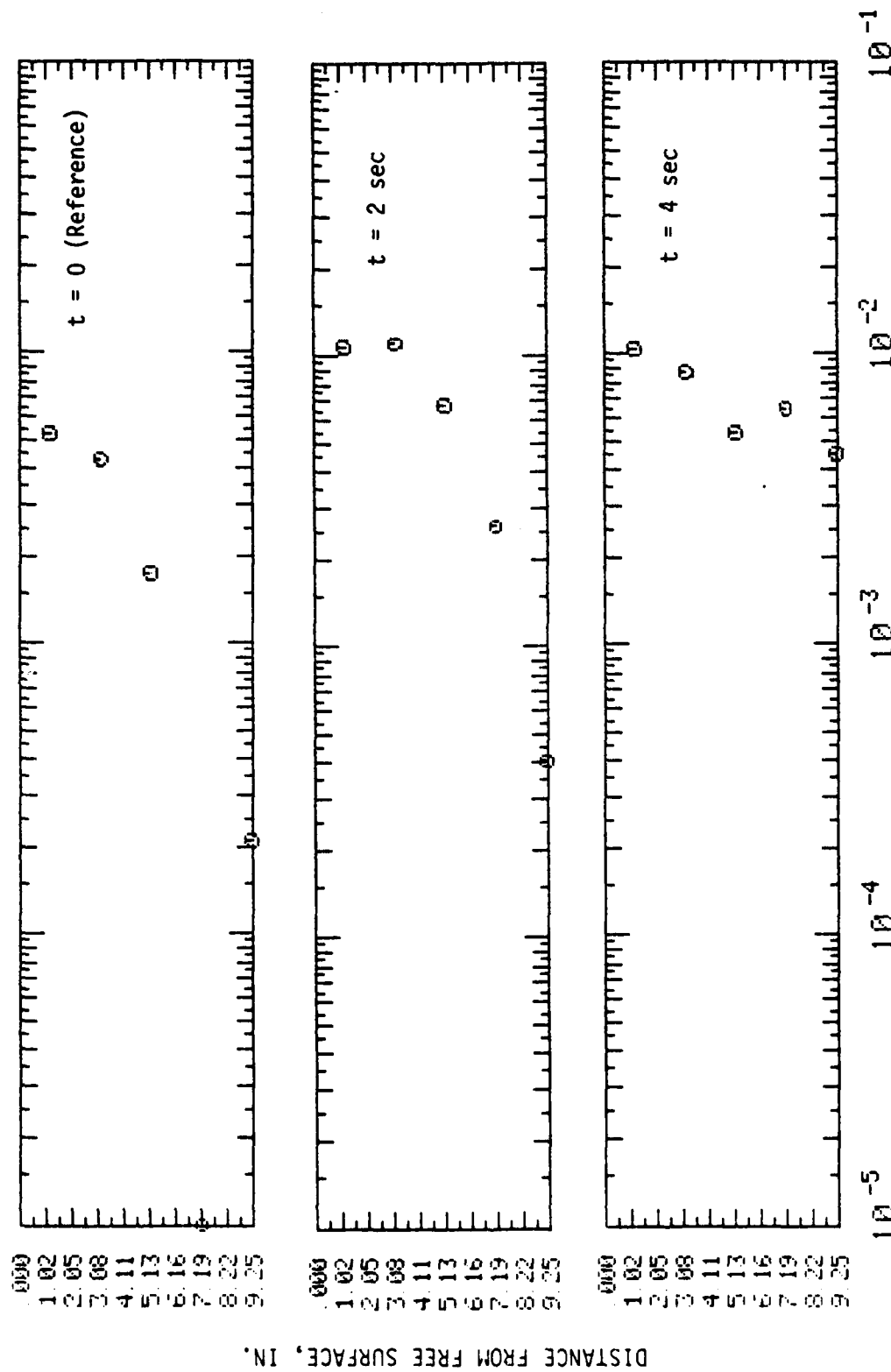
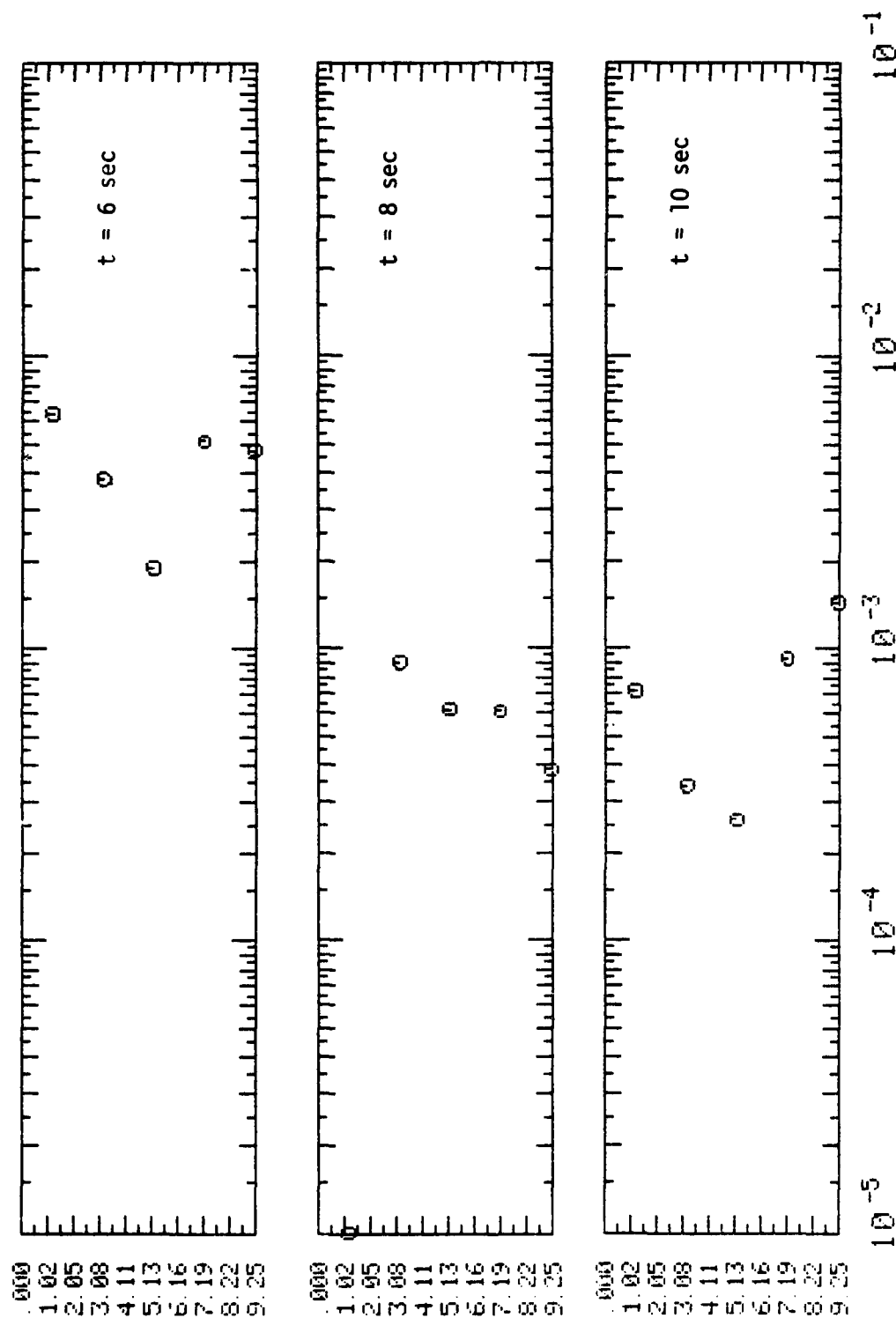


FIGURE J-2. RUN II.1-20 VERTICAL CONCENTRATION PROFILES

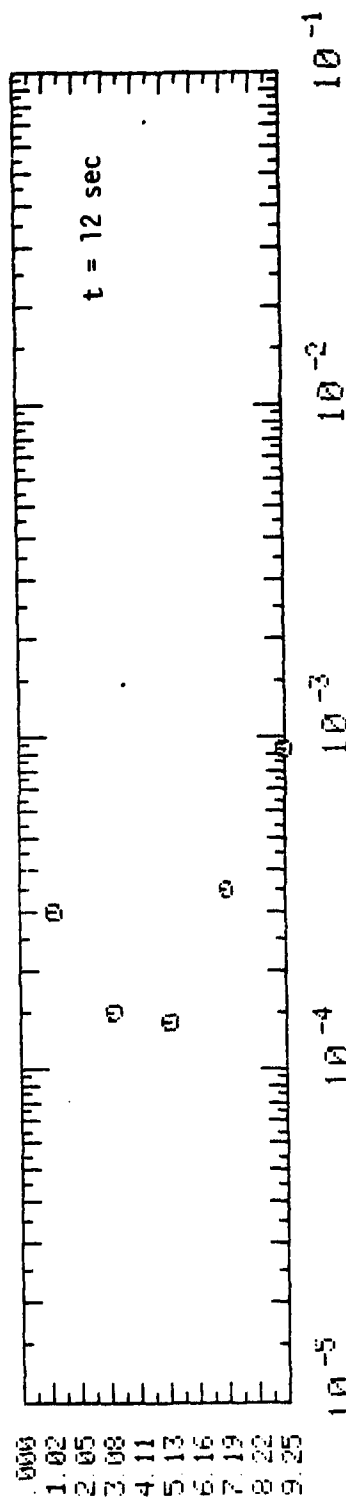


C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE J-3. RUN II.1-20 VERTICAL CONCENTRATION PROFILES

J-4



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Y = 0$

FIGURE J-4. RUN II.1-20 VERTICAL CONCENTRATION PROFILES

APPENDIX K

CONCENTRATION PROFILES FOR
RUN I.2-3 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 0.79$$

$$J = 0.79$$

$$Fr = -0.97$$

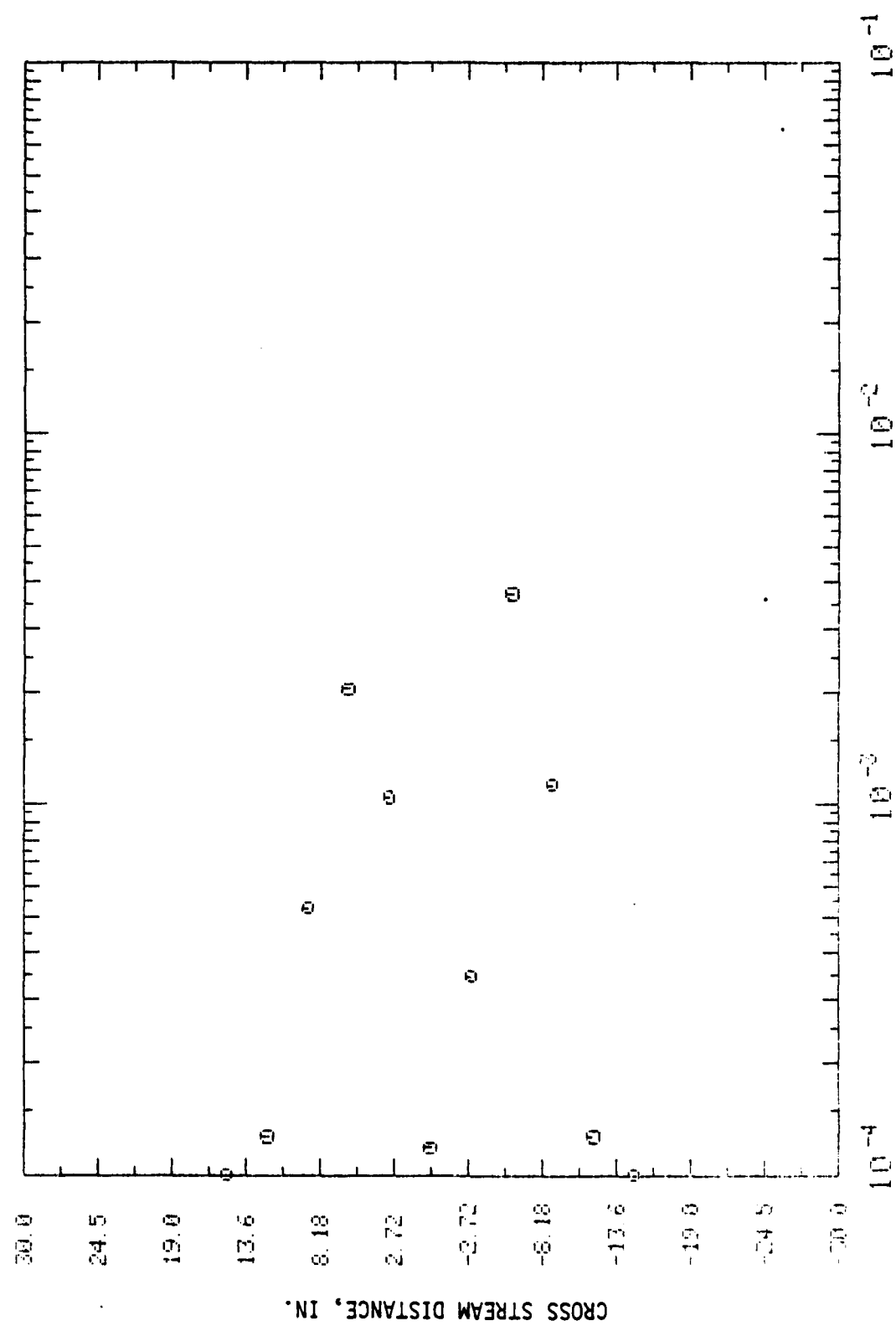


FIGURE K-1. RUN I. 2-3 CROSS STREAM CONCENTRATION PROFILE

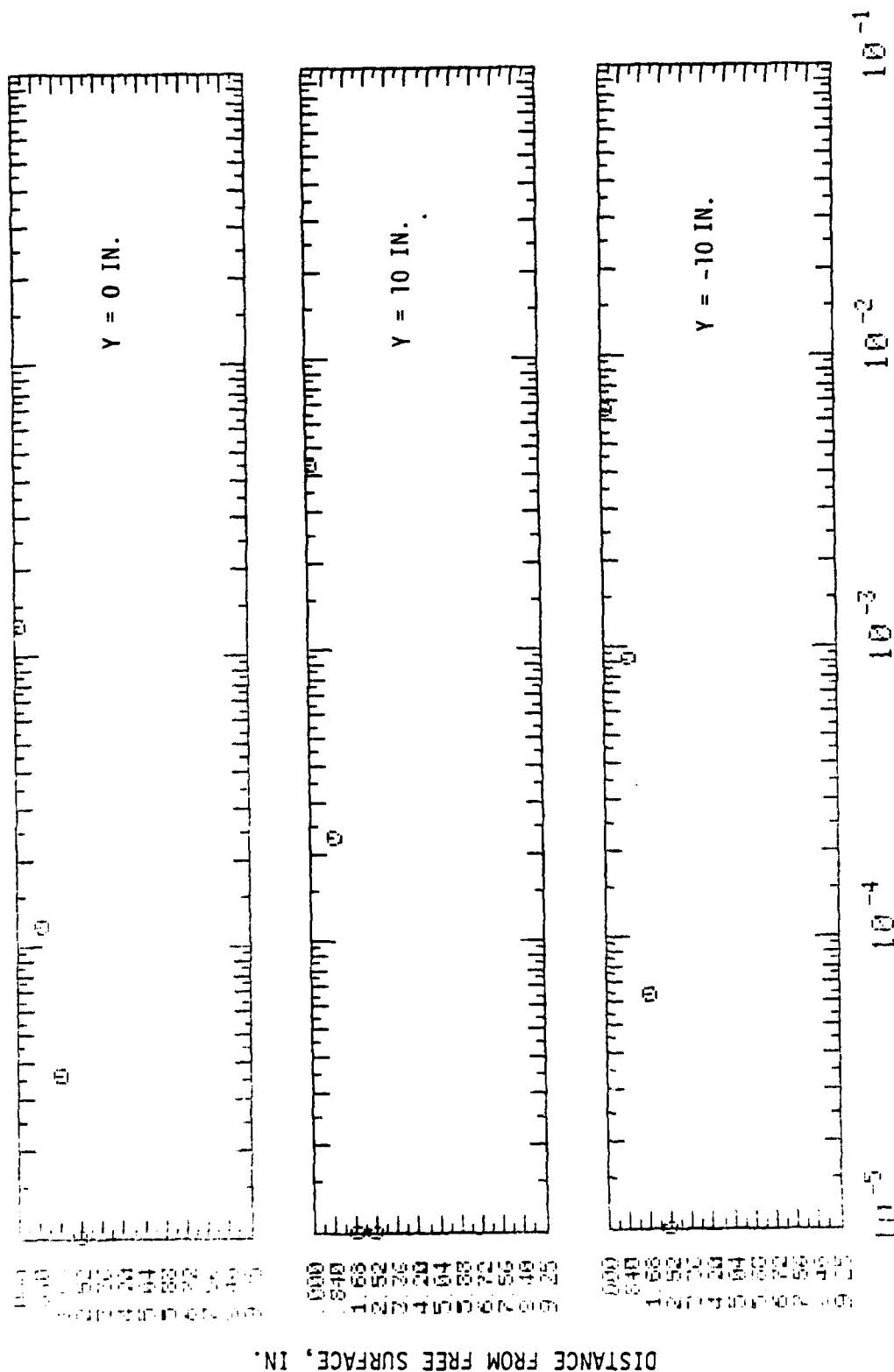
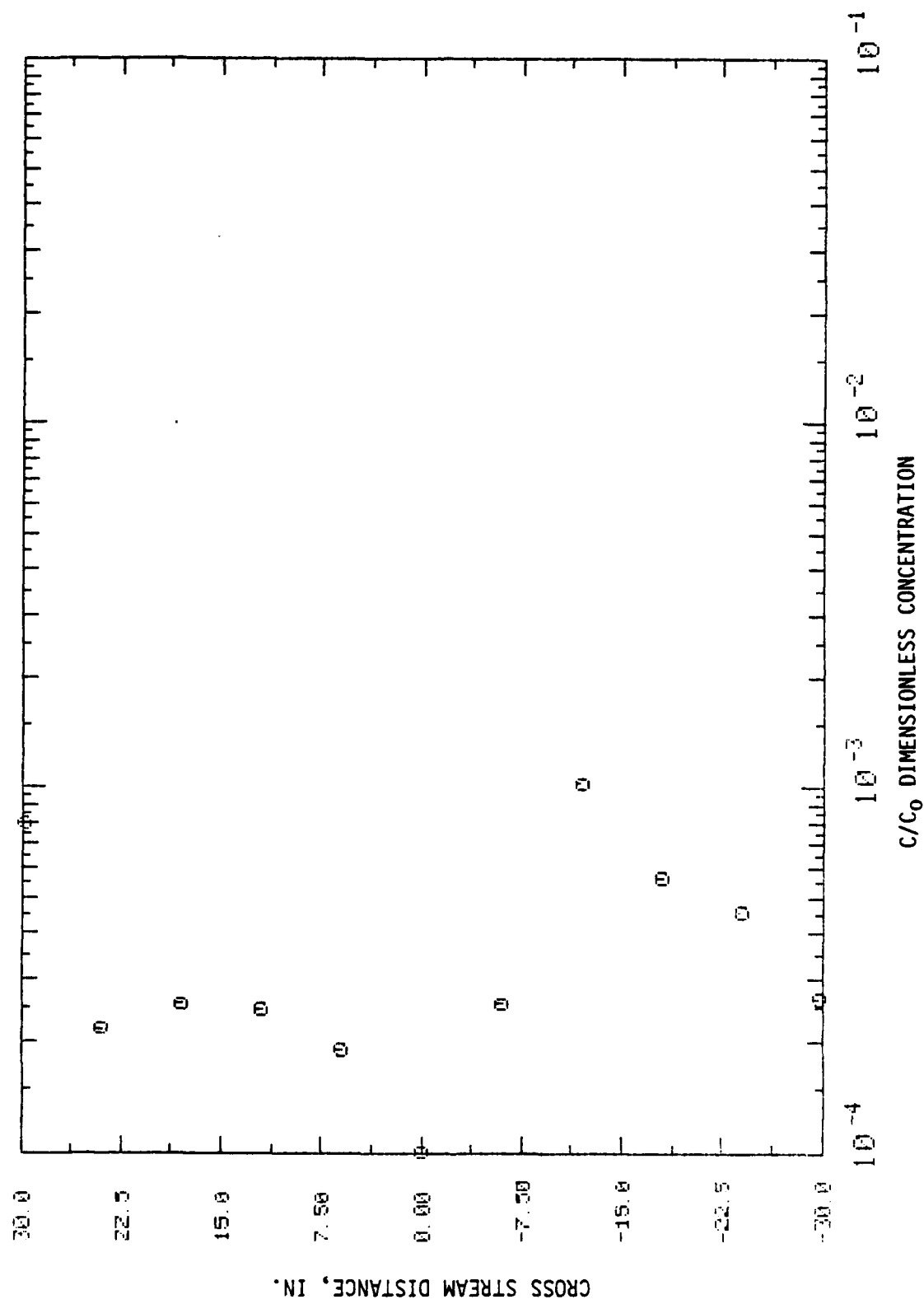


FIGURE K-2. RUN I. 2-3 VERTICAL CONCENTRATION PROFILES



X = 120 IN., Z = 1 IN.

FIGURE K-3. RUN 1. 2-3 CROSS STREAM CONCENTRATION PROFILE

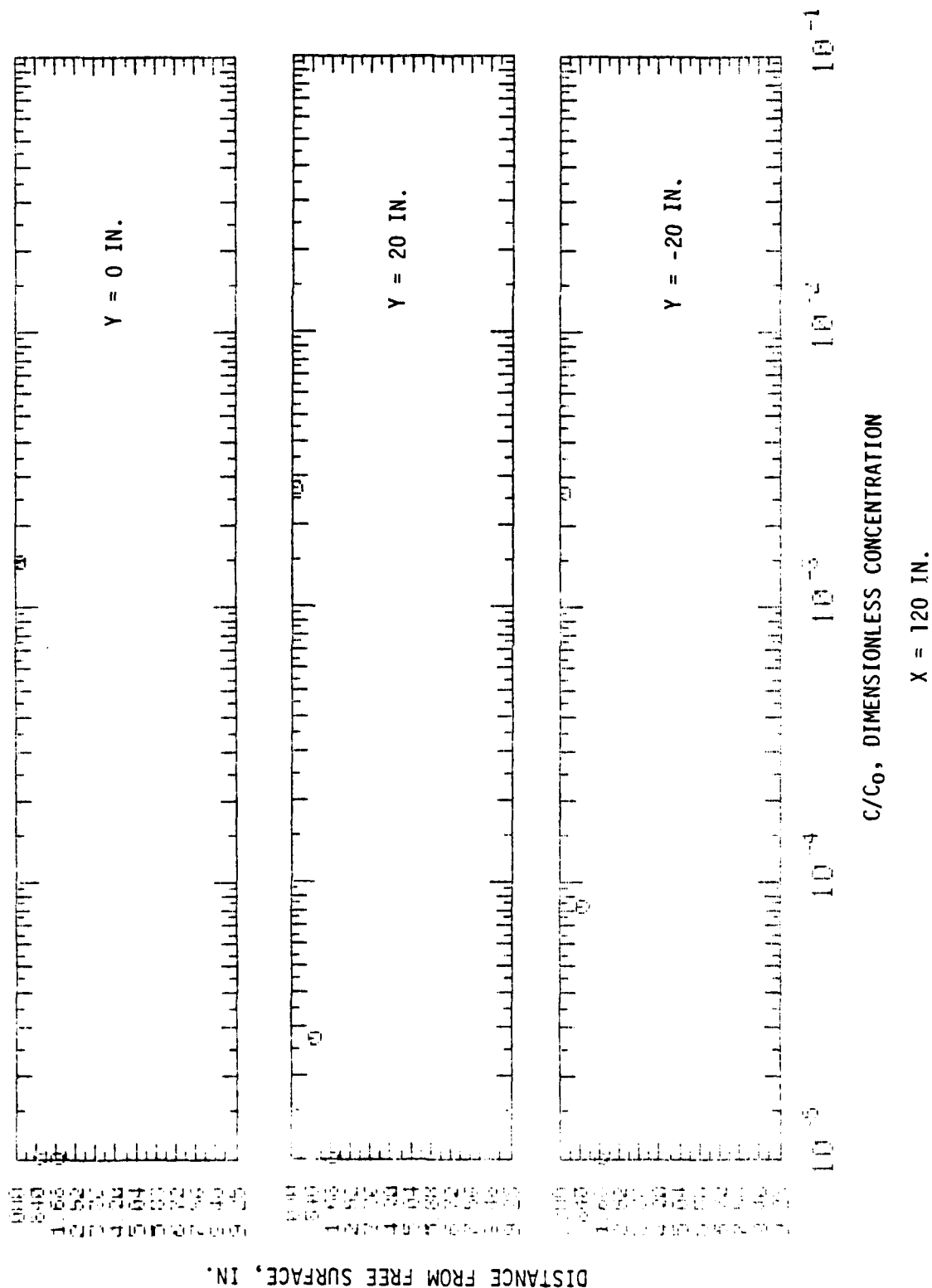


FIGURE K-4. RUN I. 2-3 VERTICAL CONCENTRATION PROFILES

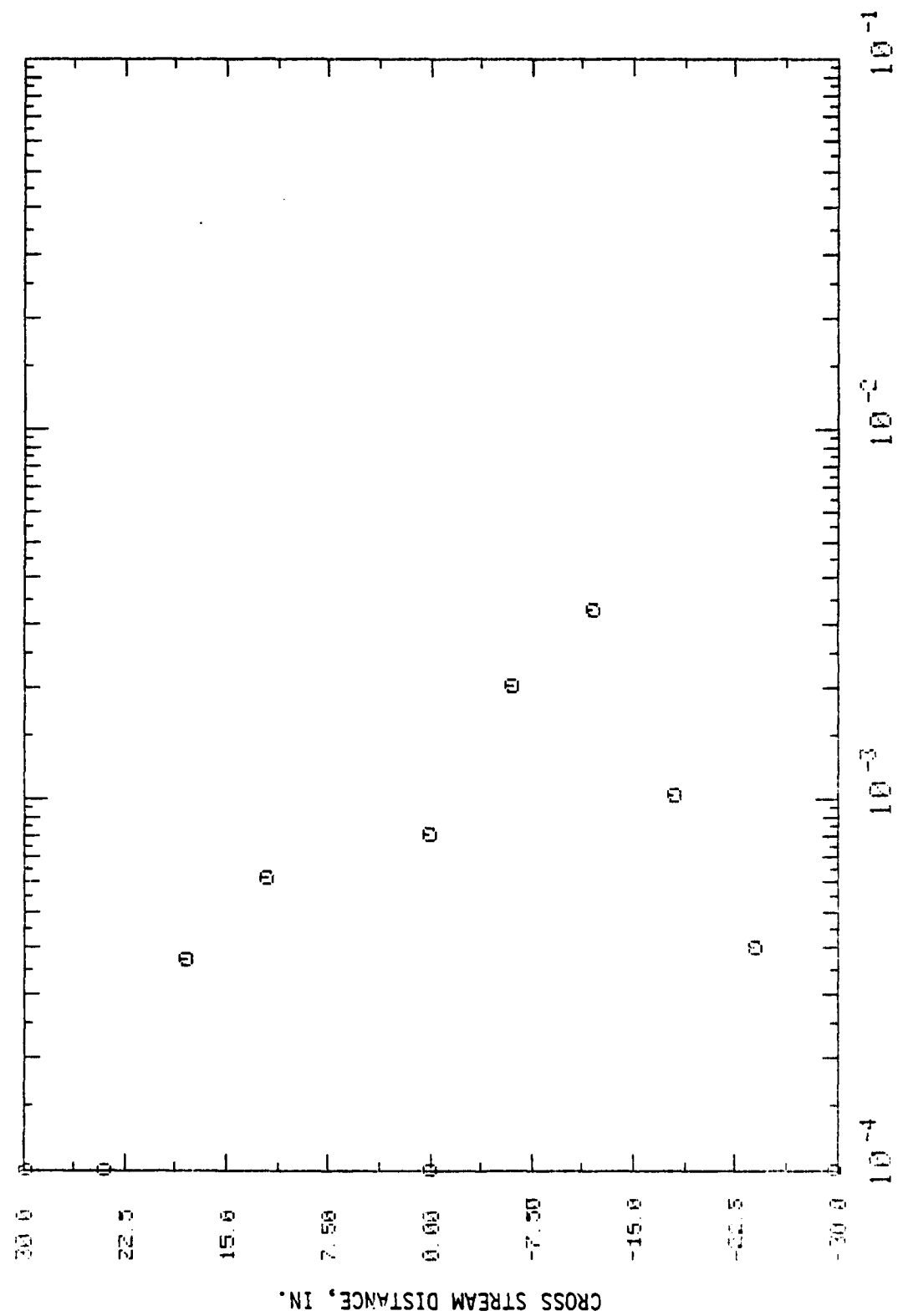
APPENDIX L

CONCENTRATION PROFILES FOR
RUN I.2-4 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 0.79$$

$$J = 12.6$$

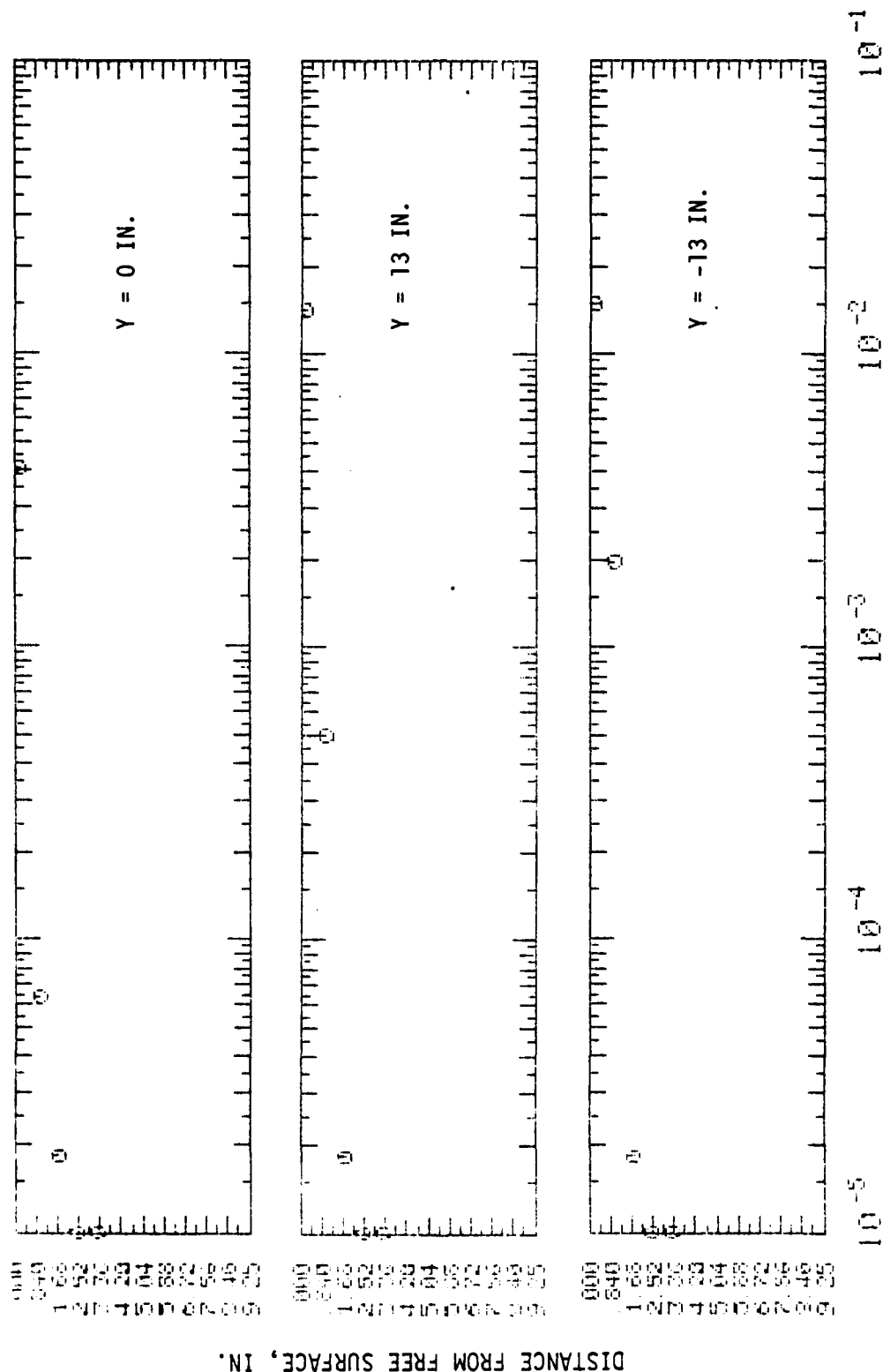
$$Fr = -0.97$$



C/C_0 DIMENSIONLESS CONCENTRATION

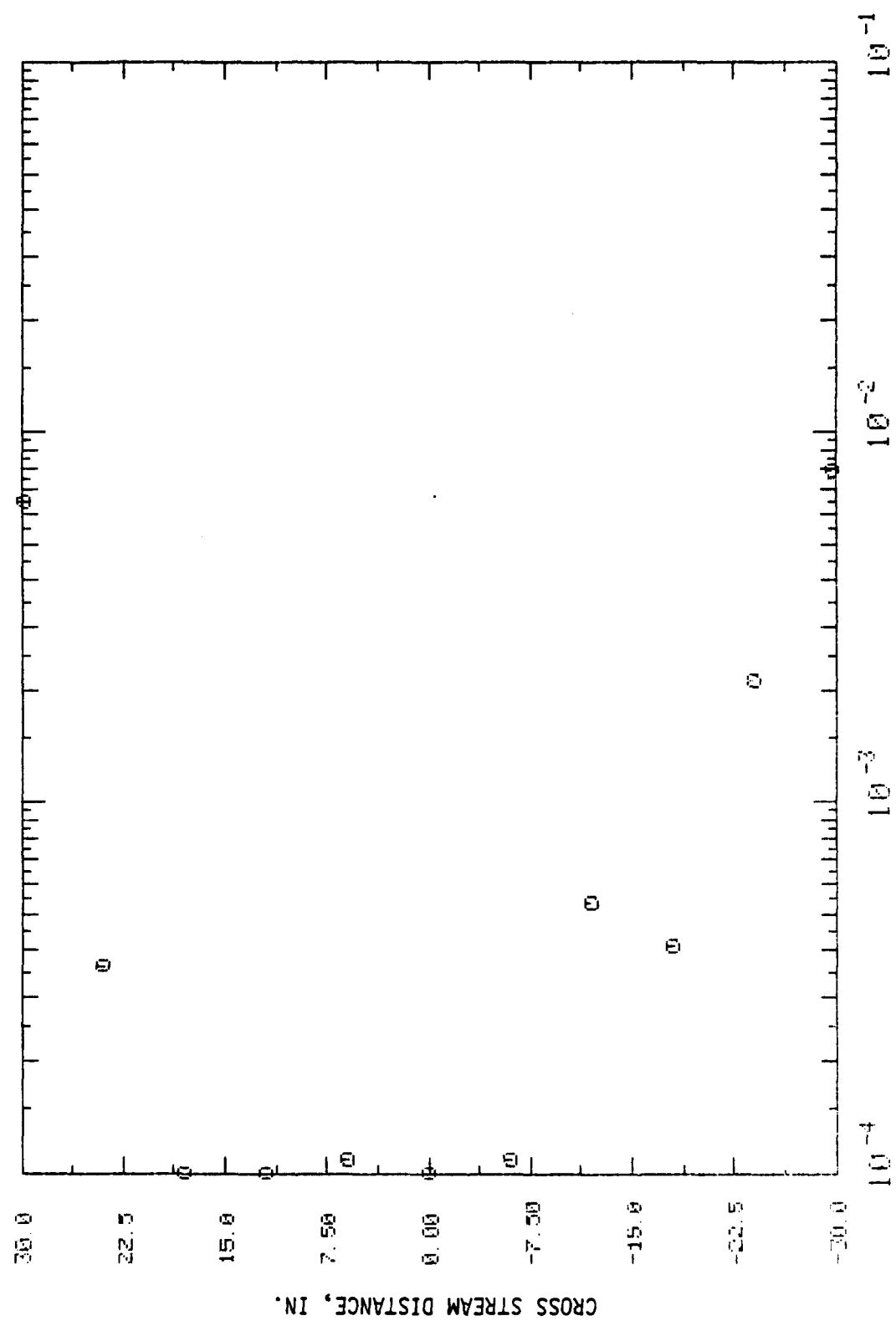
$X = 48$ IN., $Z = 1$ IN.

FIGURE L-1. RUN I. 2-4 CROSS STREAM CONCENTRATION PROFILE



X = 48 IN.

FIGURE L-2. RUN I. 2-4 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 1 IN.

FIGURE L-3. RUN I. 2-4 CROSS STREAM CONCENTRATION PROFILE

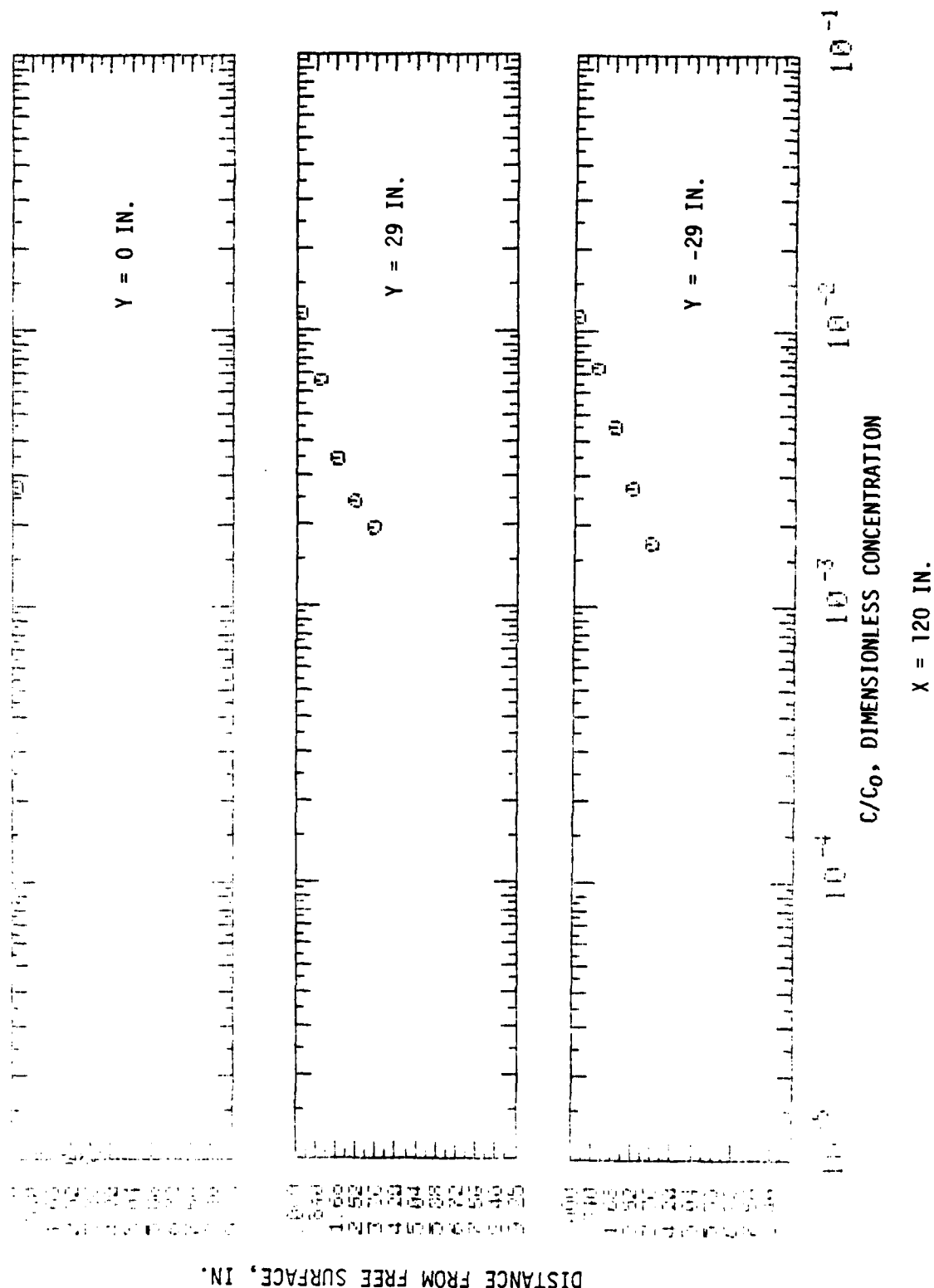


FIGURE L-4. RUN I. 2-4 VERTICAL CONCENTRATION PROFILES

APPENDIX M

CONCENTRATION PROFILES FOR
RUN I.2-9 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 1.05$$

$$J = 16.8$$

$$Fr = 0.26$$

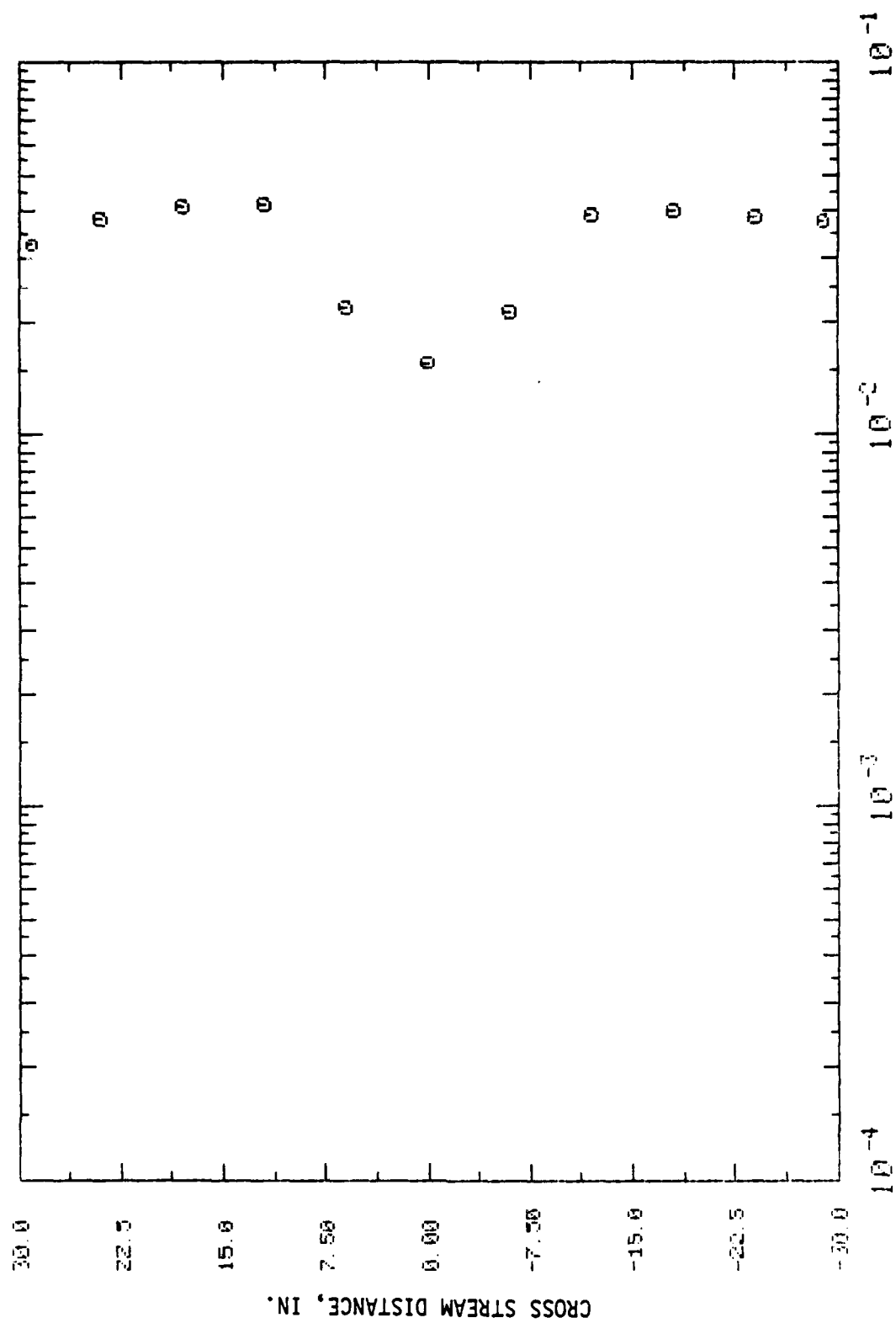


FIGURE M-1. RUN I. 2-9 CROSS STREAM CONCENTRATION PROFILE

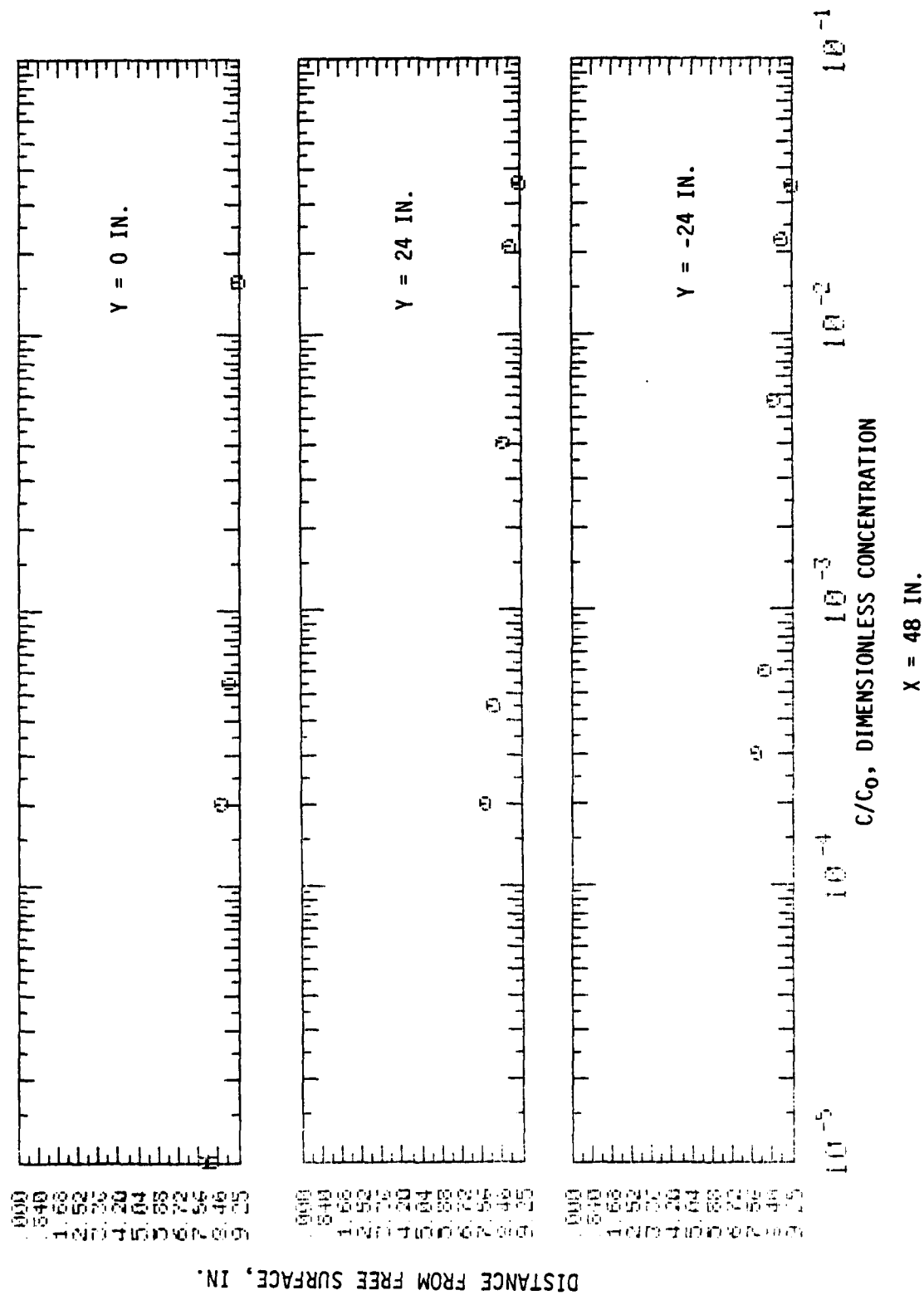


FIGURE M-2. RUN I. 2-9 VERTICAL CONCENTRATION PROFILES

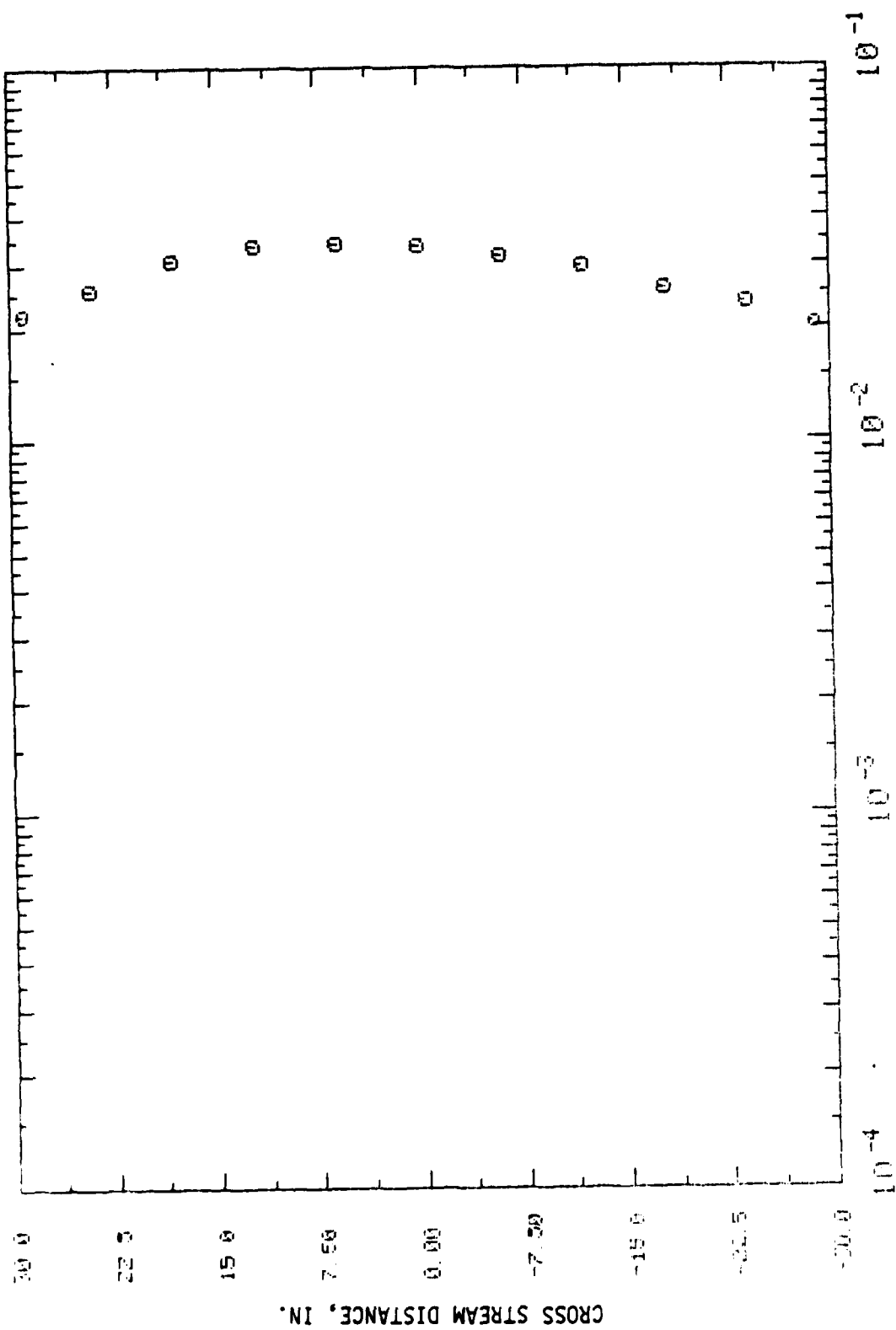


FIGURE M-3. RUN I. 2-9 CROSS STREAM CONCENTRATION PROFILE

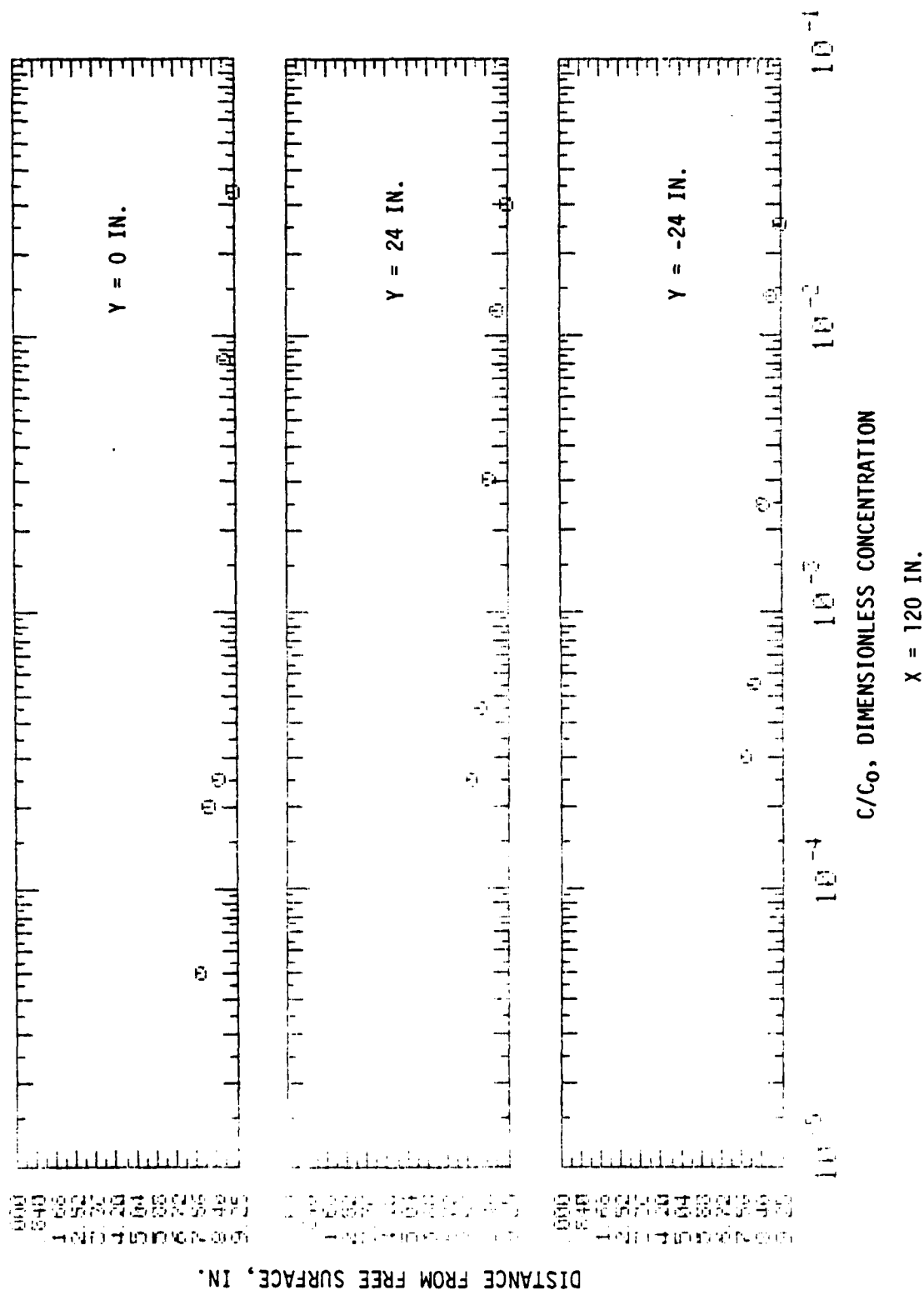


FIGURE M-4. RUN I. 2-9 VERTICAL CONCENTRATION PROFILES

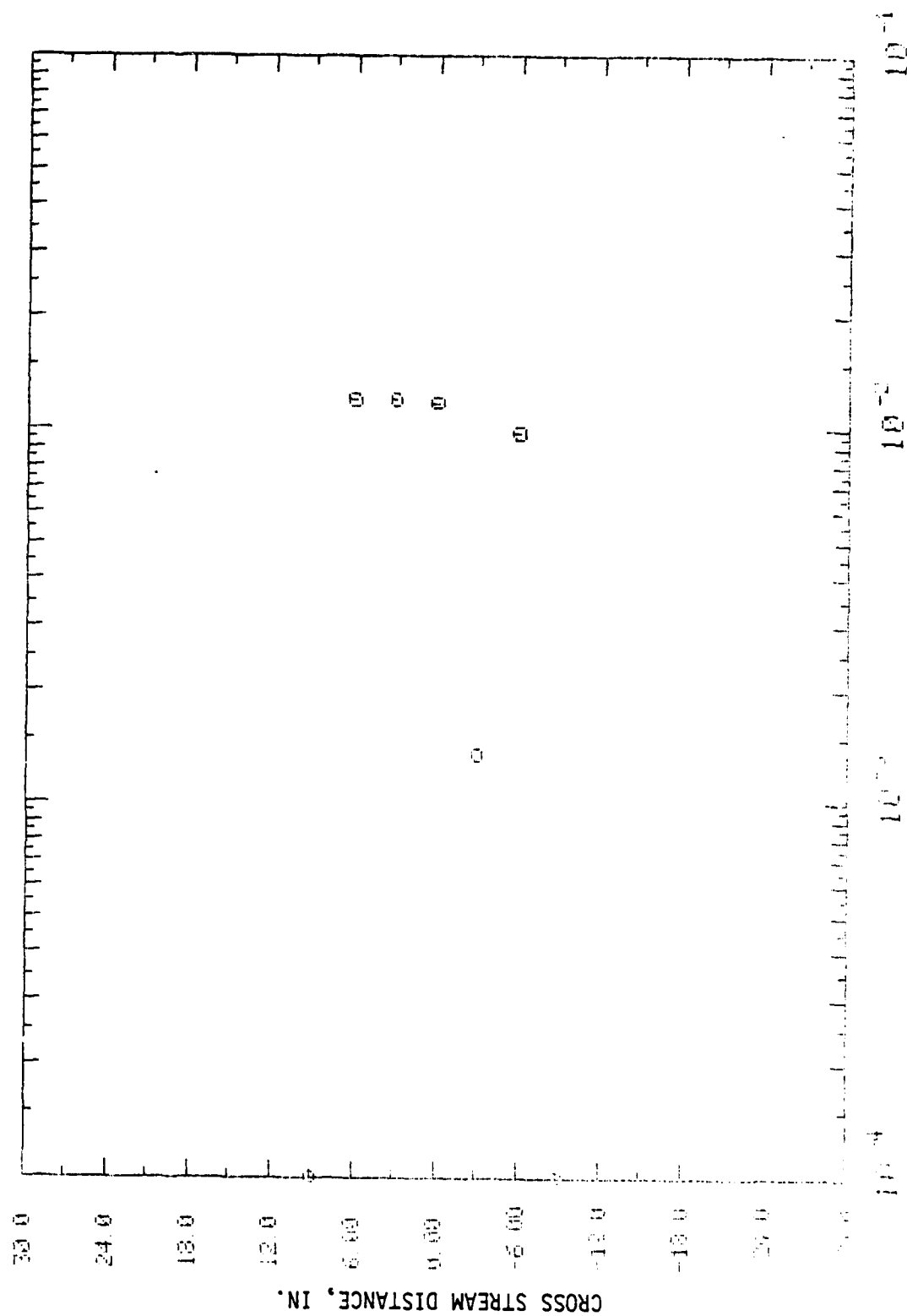
APPENDIX N

CONCENTRATION PROFILES FOR
RUN I.2-11 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 1.05$$

$$J = 1.05$$

$$Fr = 4.1$$



X = 48 IN., Z = 9.25 IN.

FIGURE N-1. RUN I. 2-11 CROSS STREAM CONCENTRATION PROFILE

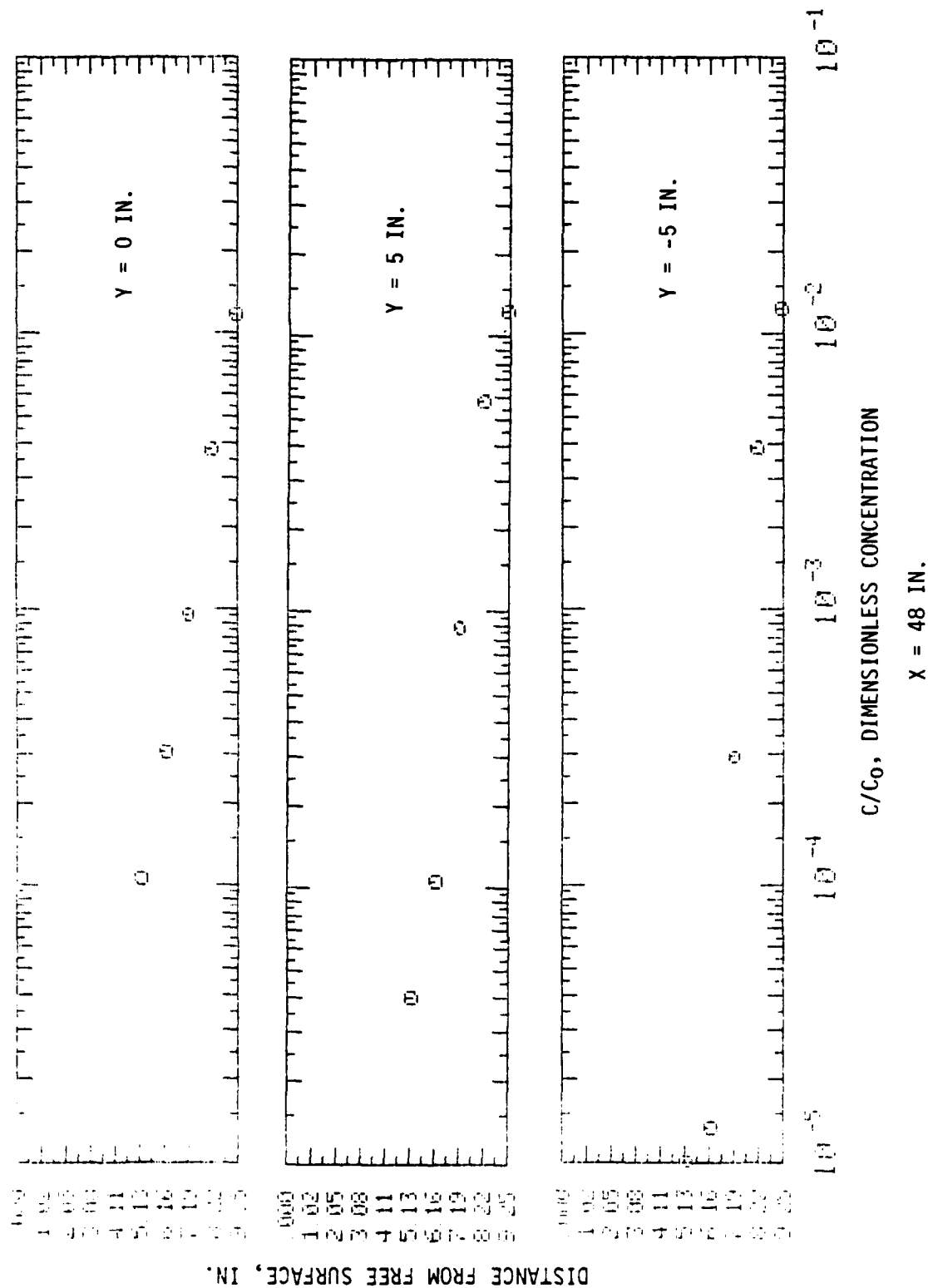
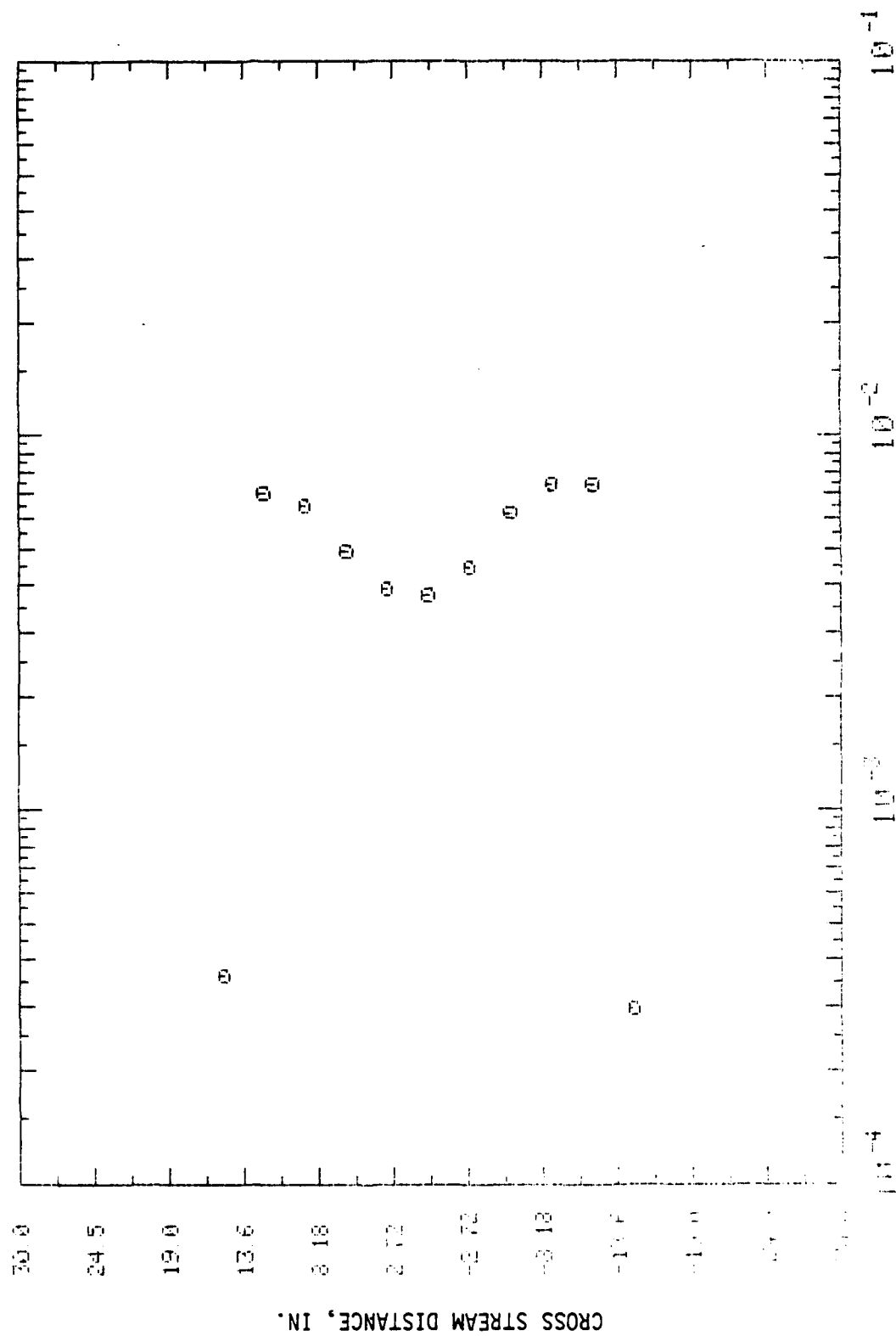


FIGURE N-2. RUN I. 2-11 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 9.25 IN.

FIGURE N-3. RUN 1. 2-11 CROSS STREAM CONCENTRATION PROFILE

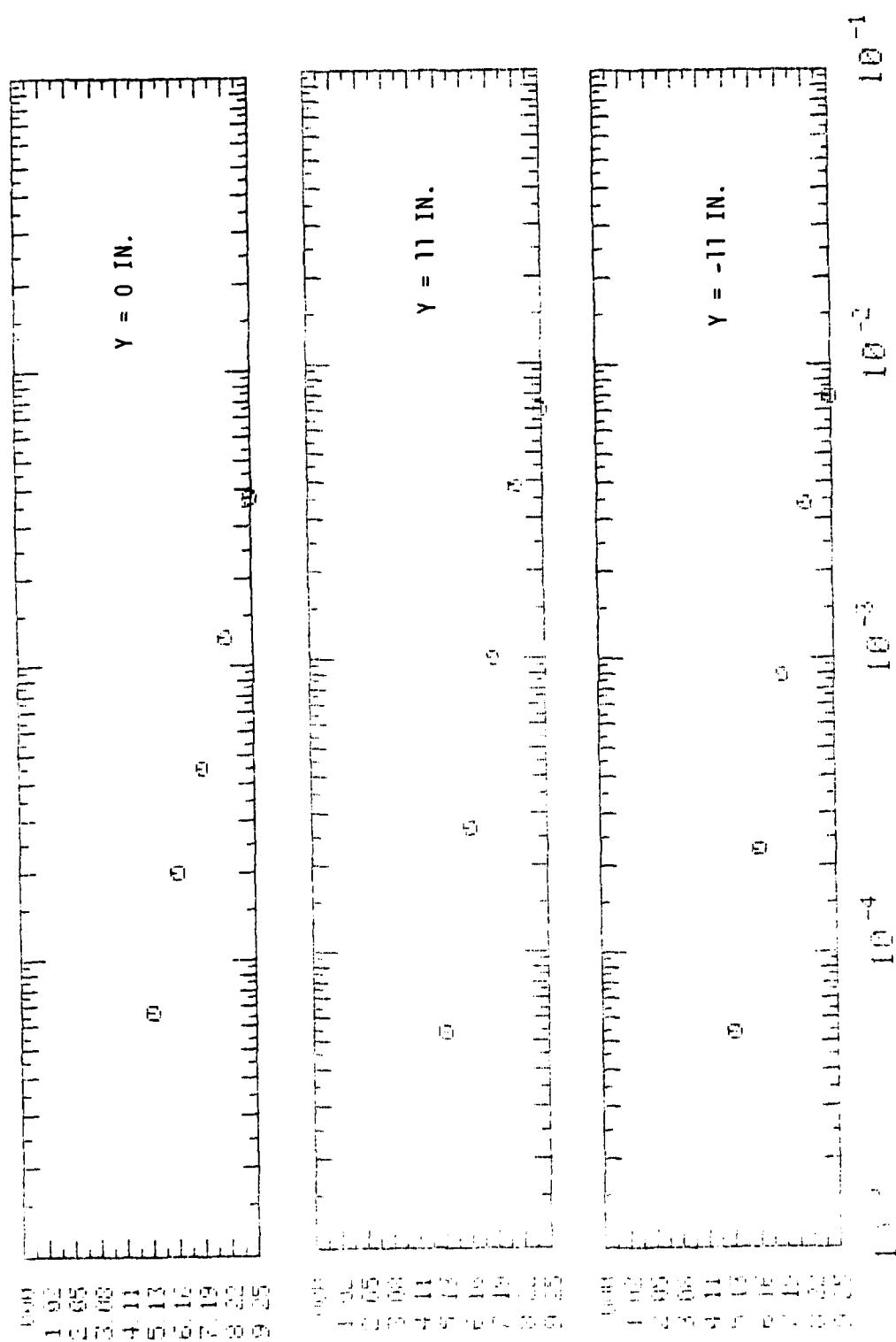


FIGURE N-4. RI² 1.2-11 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

APPENDIX O

CONCENTRATION PROFILES FOR
RUN I.2-12 AT X = 48 IN., 120 IN.,
240 IN., 288 IN., 336 IN., 432 IN.

$$\rho_c/\rho = 1.05$$

$$J = 16.8$$

$$Fr = 14.1$$

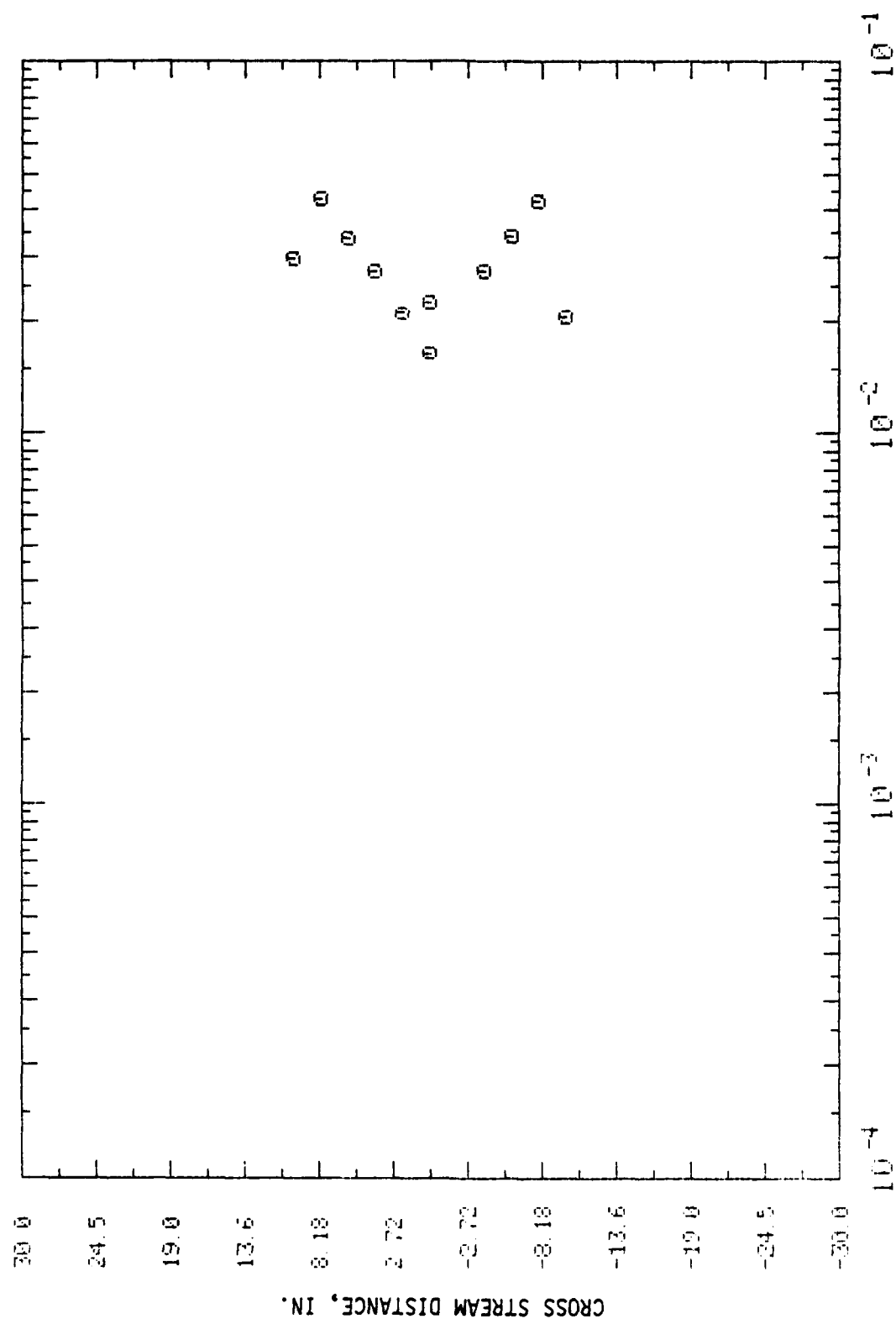
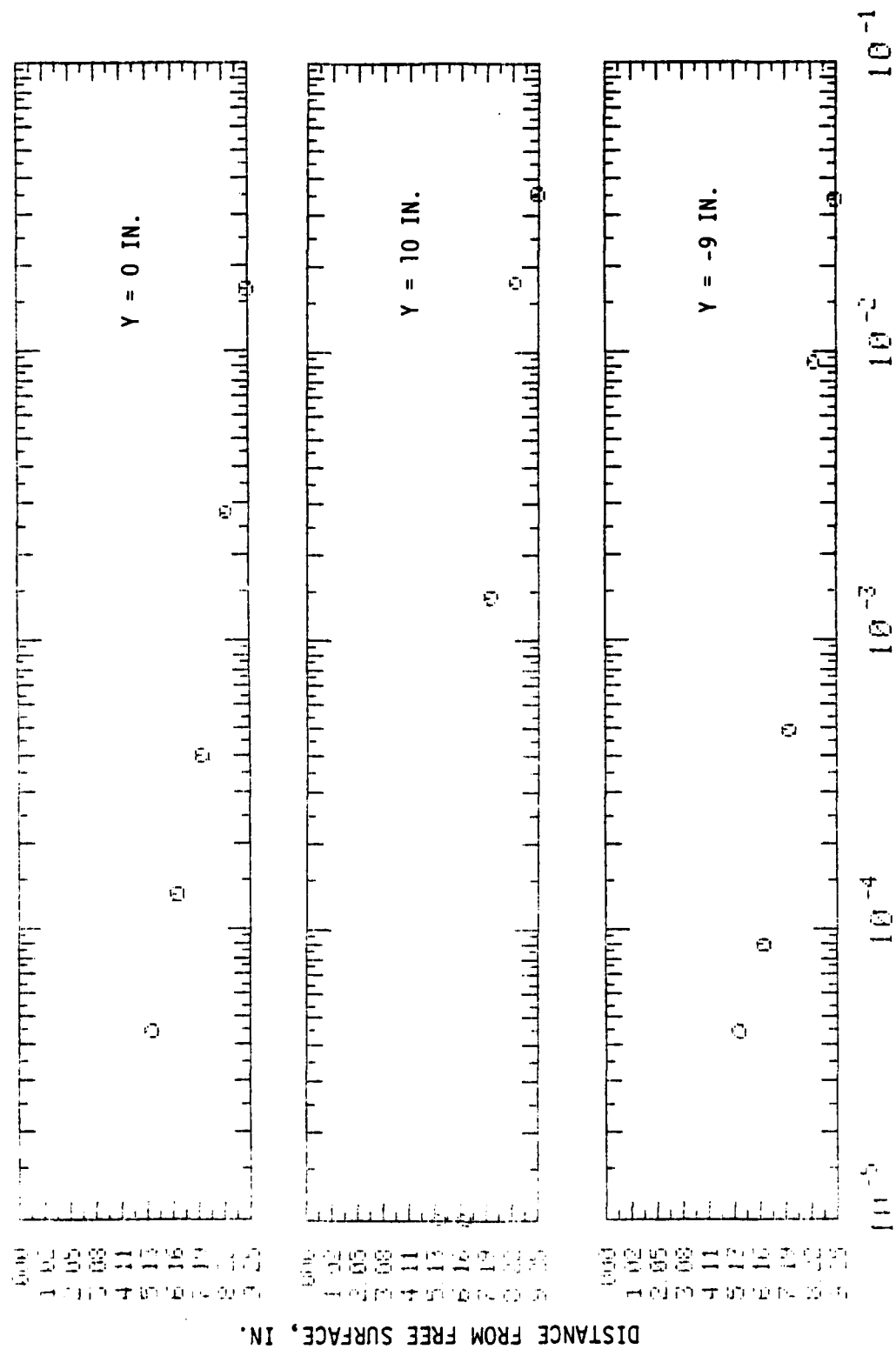


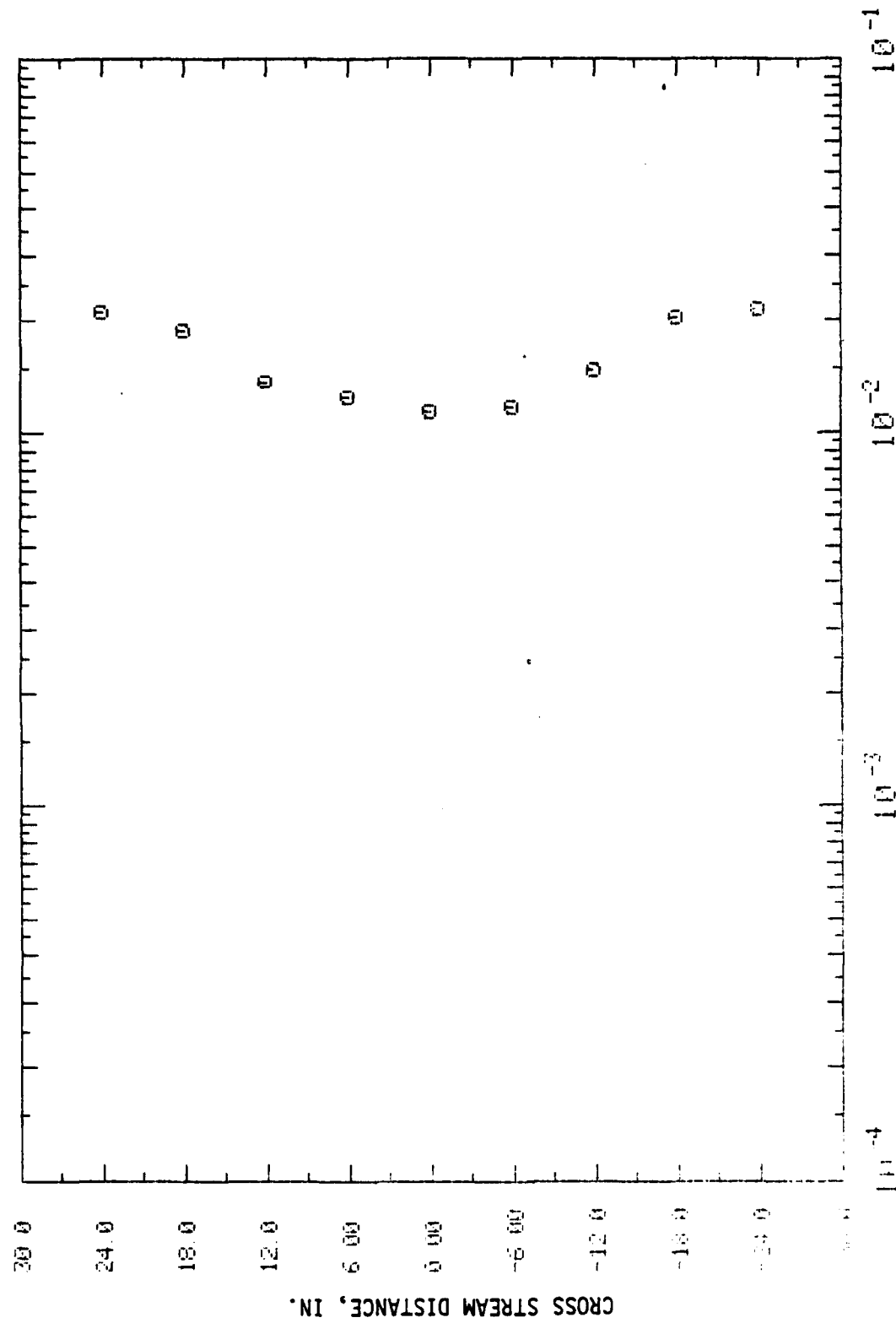
FIGURE 0-1. RUN I.2-12 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 48$ IN.

FIGURE 0-2. RUN I.2-12 VERTICAL CONCENTRATION PROFILES



X = 120 IN., Z = 9.37 IN.

FIGURE 0-3. RUN 1.2-12 CROSS STREAM CONCENTRATION PROFILE

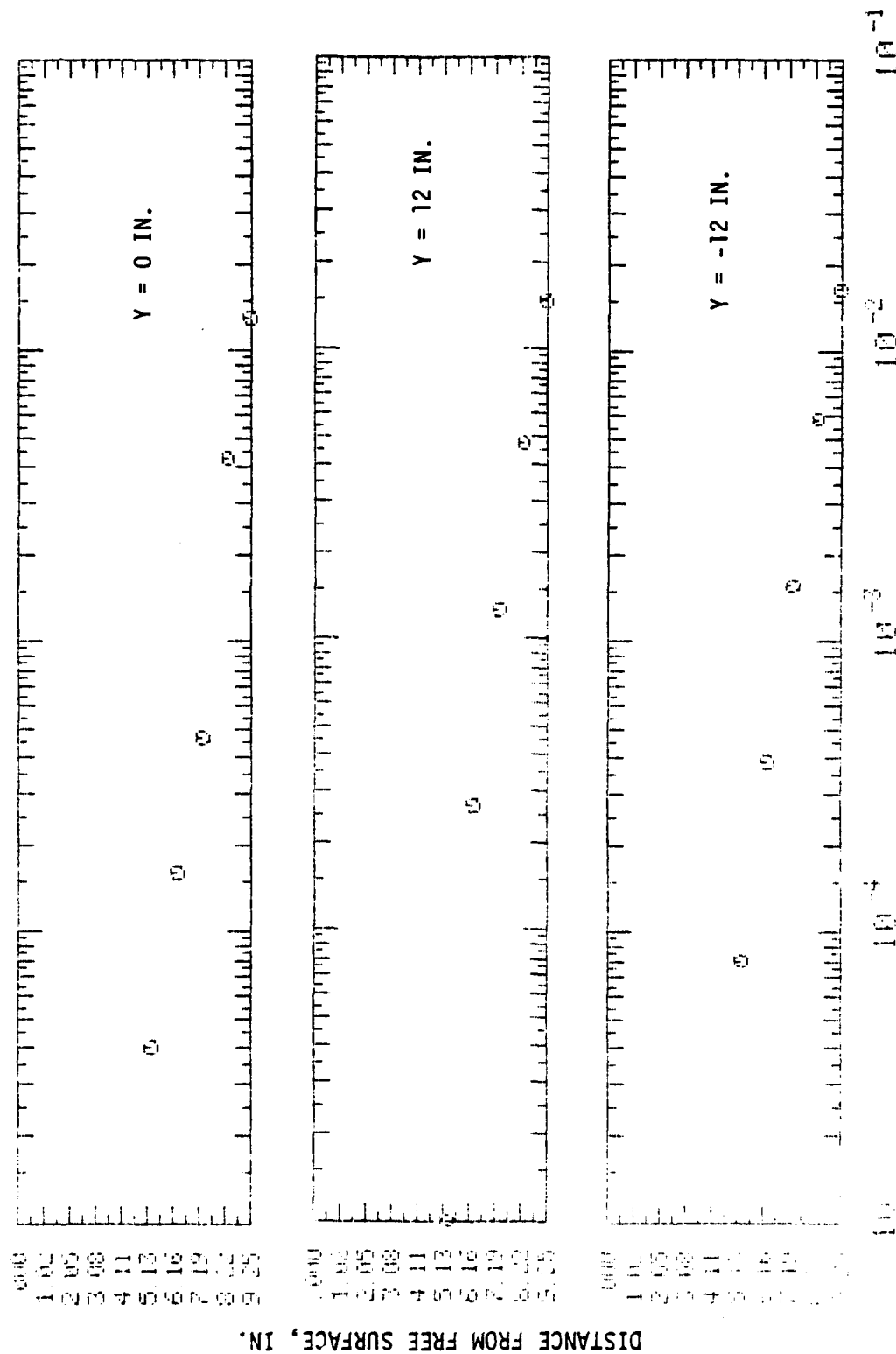


FIGURE 0-4. RUN I.2-12 VERTICAL CONCENTRATION PROFILES

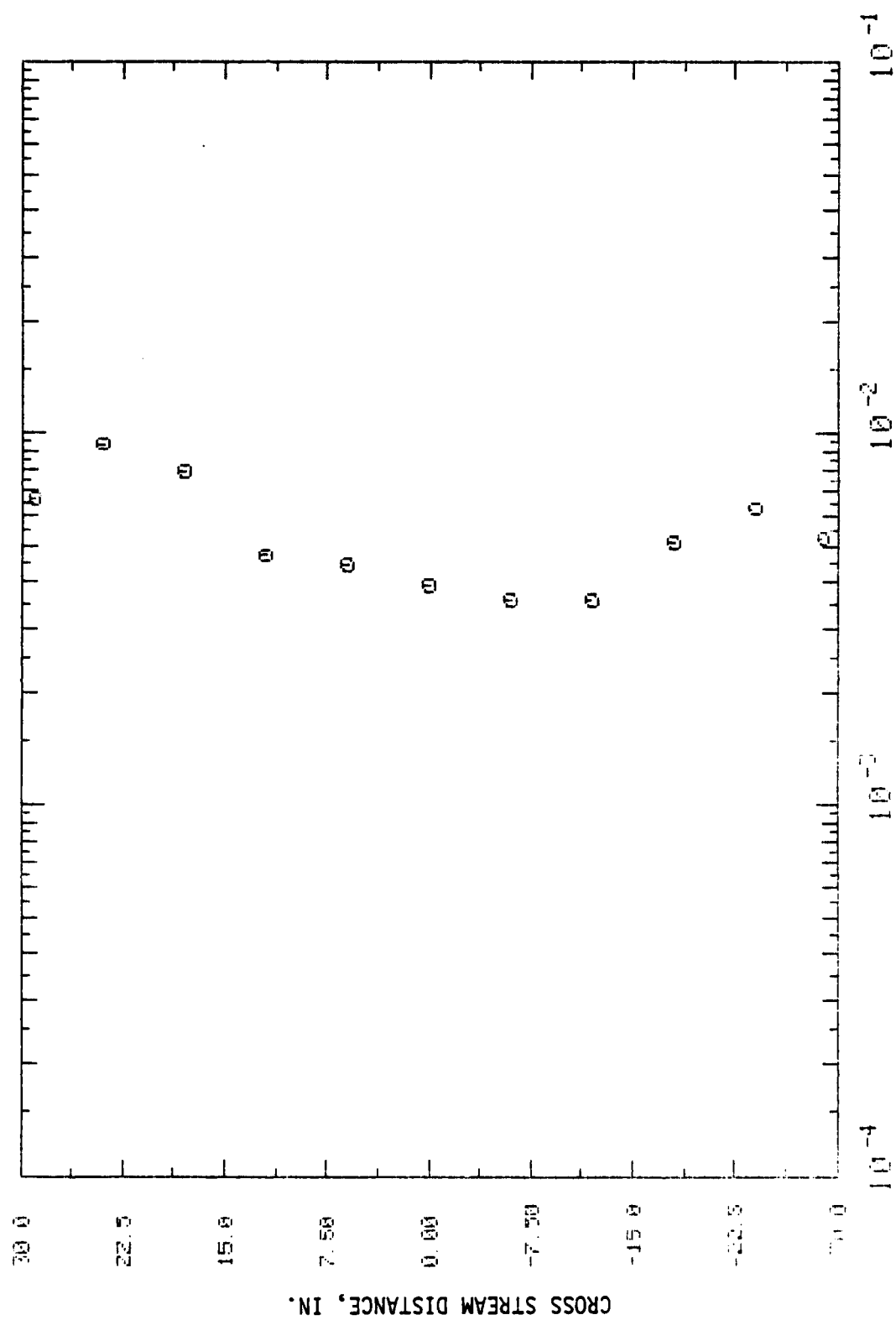


FIGURE 0-5. RUN I.2-12 CROSS STREAM CONCENTRATION PROFILE

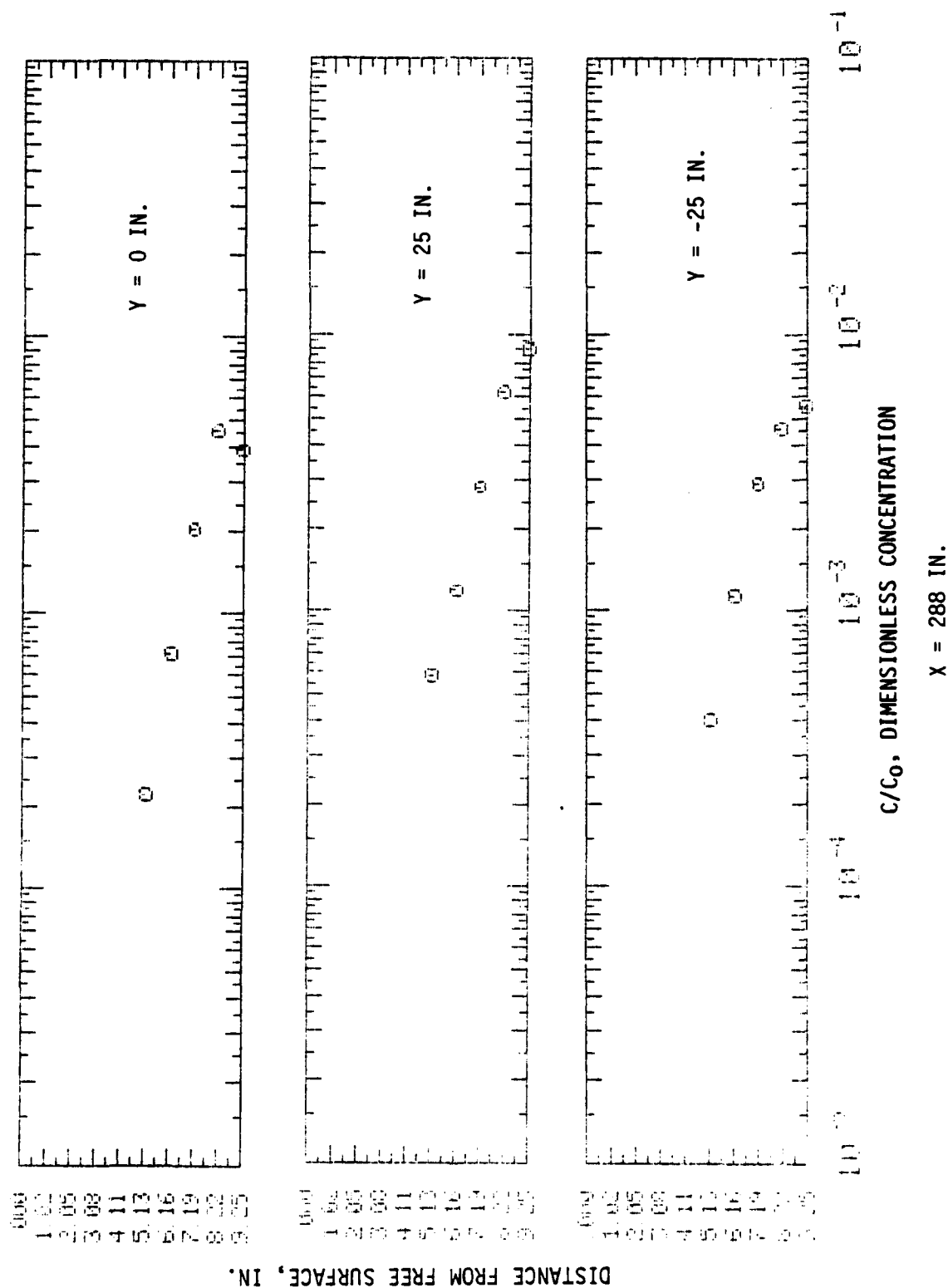


FIGURE 0-6. RUN I. 2-12 VERTICAL CONCENTRATION PROFILES

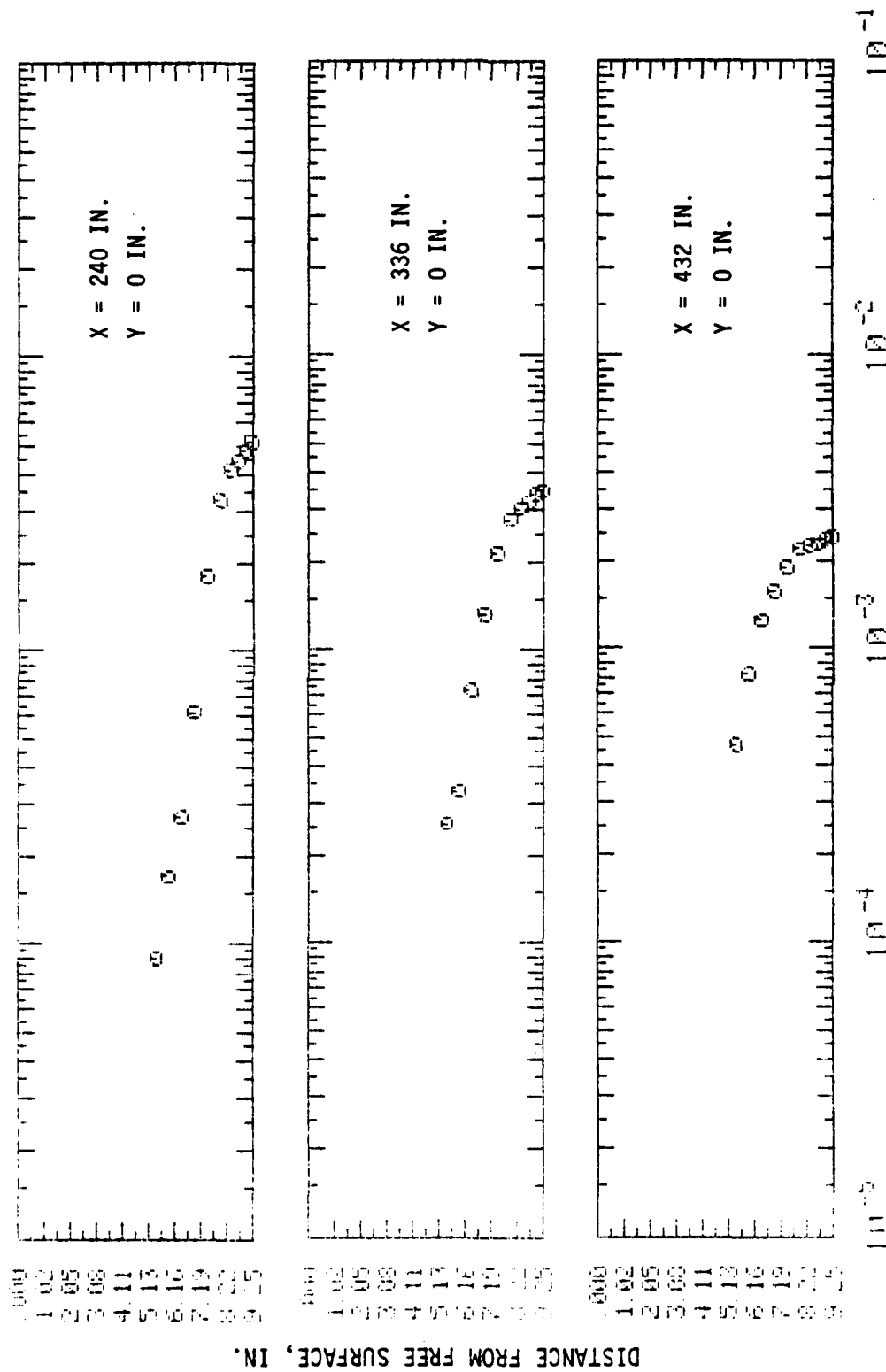


FIGURE 0-7. RUN I.2-12 VERTICAL CONCENTRATION PROFILES

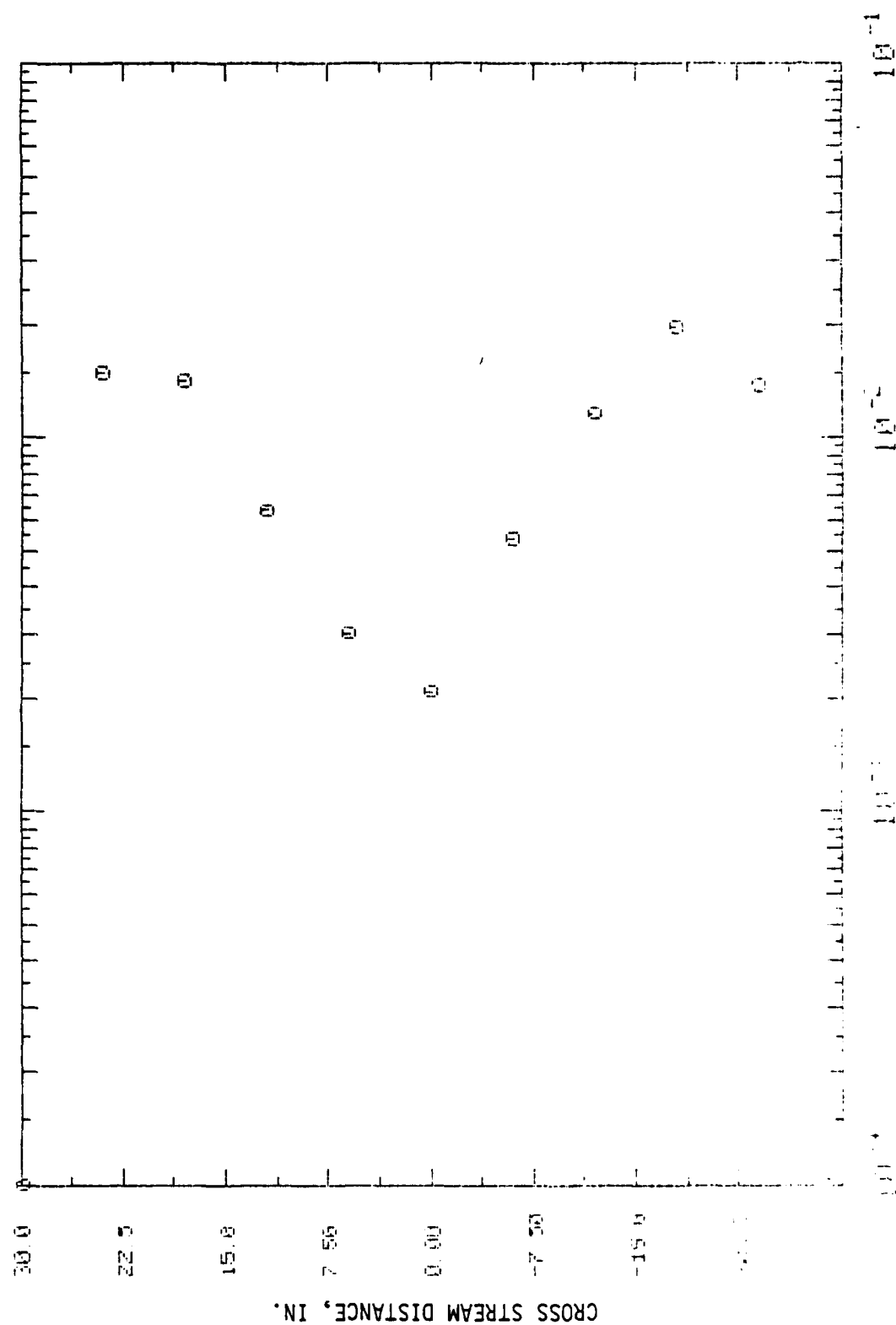
APPENDIX P

CONCENTRATION PROFILES FOR
RUN I.2-19 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 1.4$$

$$J = 1.4$$

$$Fr = 0.51$$



$X = 48 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE P-1. RUN 1. 2-19 CROSS STREAM CONCENTRATION PROFILE

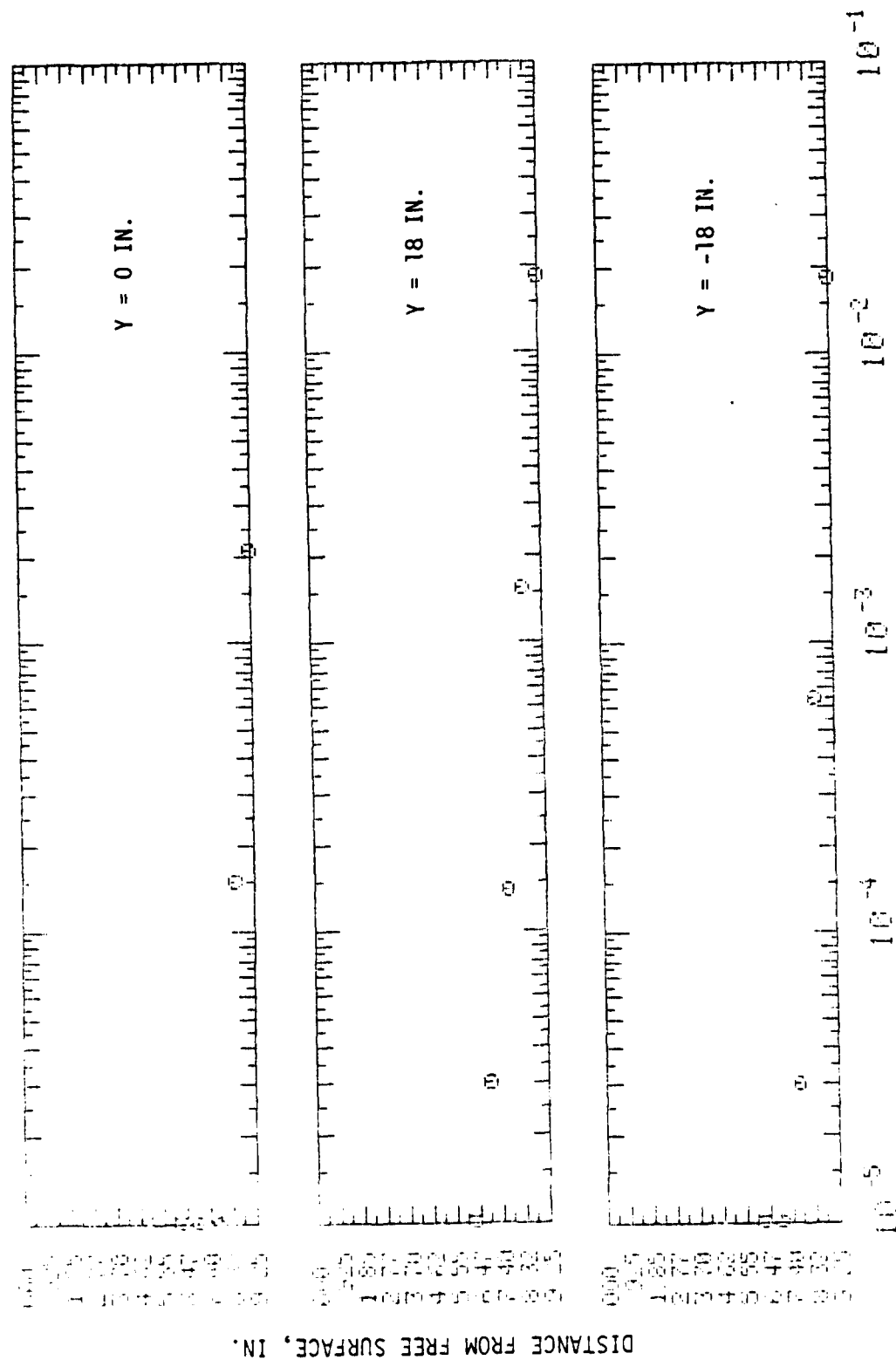
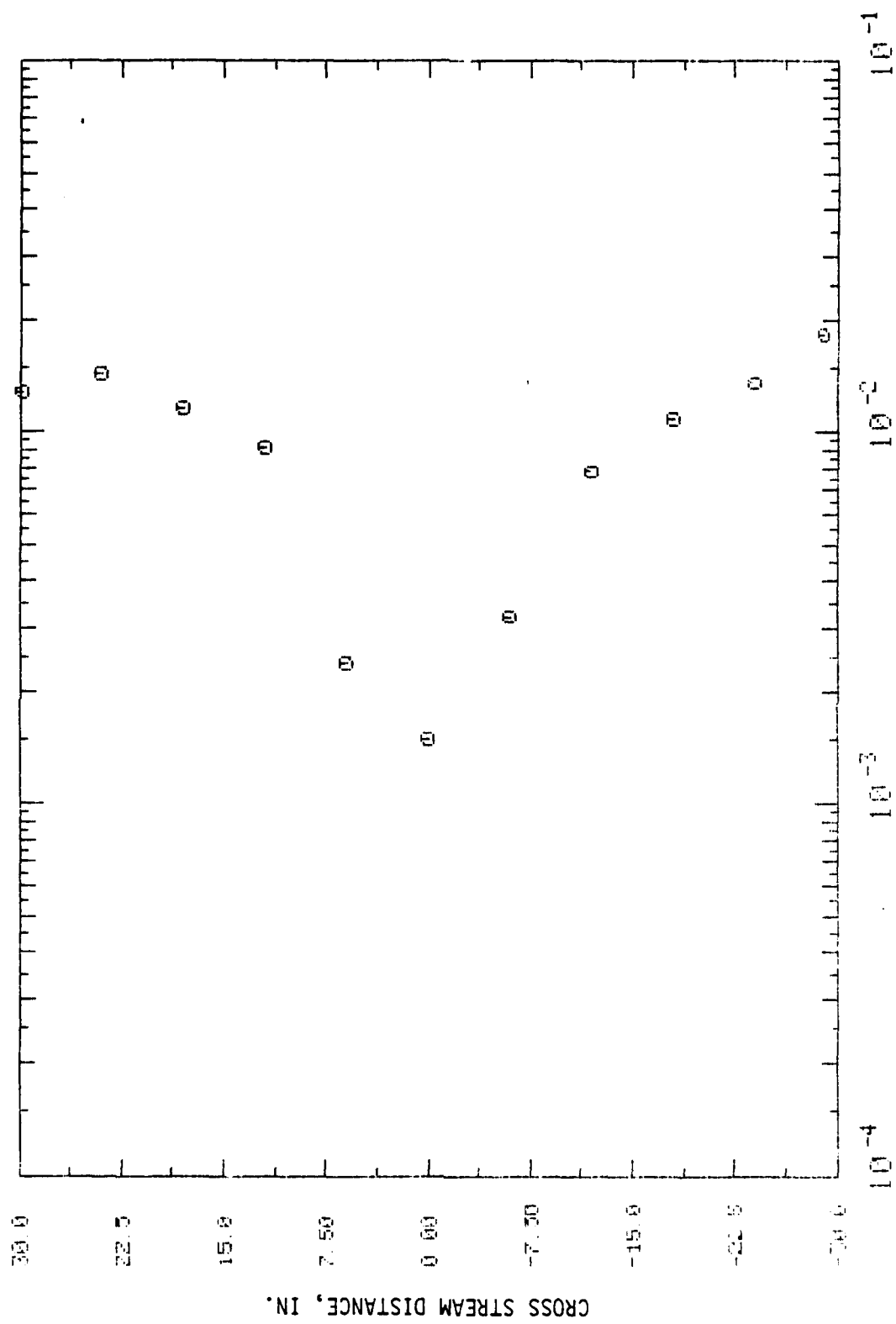


FIGURE P-2. RUN I. 2-19 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 9.25 IN.

FIGURE P-3. RUN 1. 2-19 CROSS STREAM CONCENTRATION PROFILE

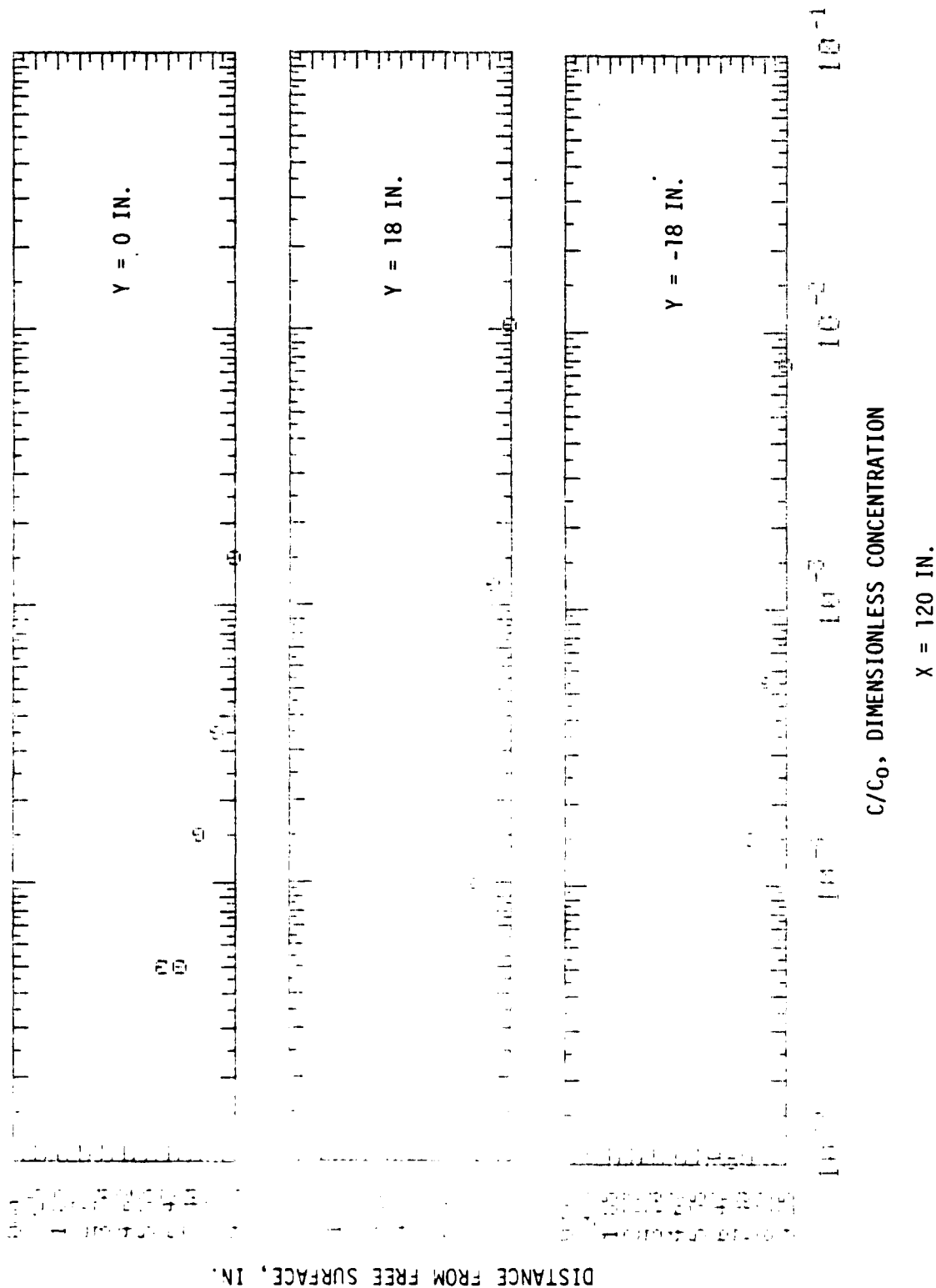


FIGURE P-4. RUN I. 2-19 VERTICAL CONCENTRATION PROFILES

APPENDIX Q

CONCENTRATION PROFILES FOR
RUN I.2-20 AT X = 48 IN., 120 IN.,
240 IN., 336 IN., 432 IN.

$$\rho_c/\rho = 1.4$$

$$J = 22.4$$

$$Fr = 0.51$$

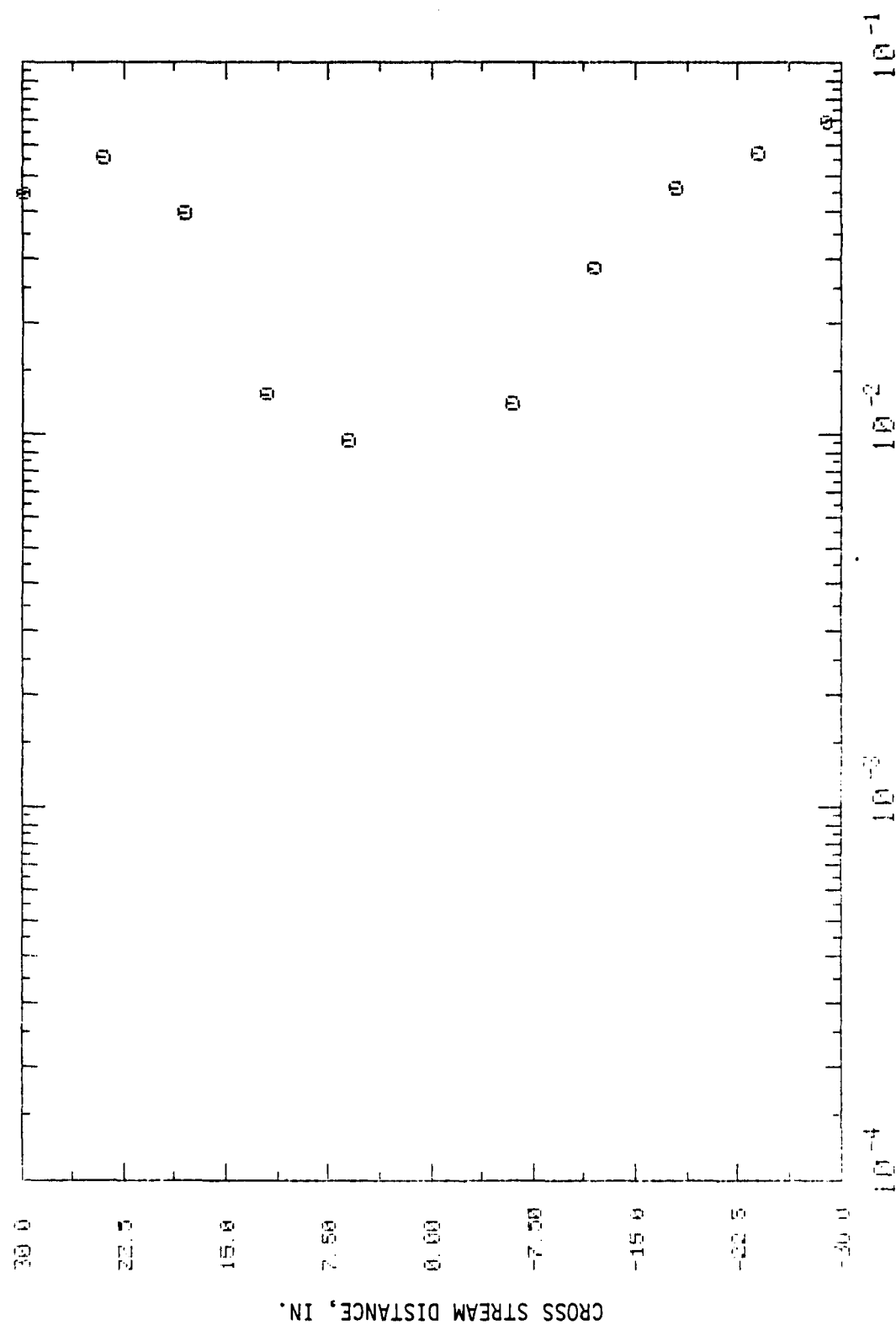


FIGURE Q-1. RUN I.2-20 CROSS STREAM CONCENTRATION PROFILE

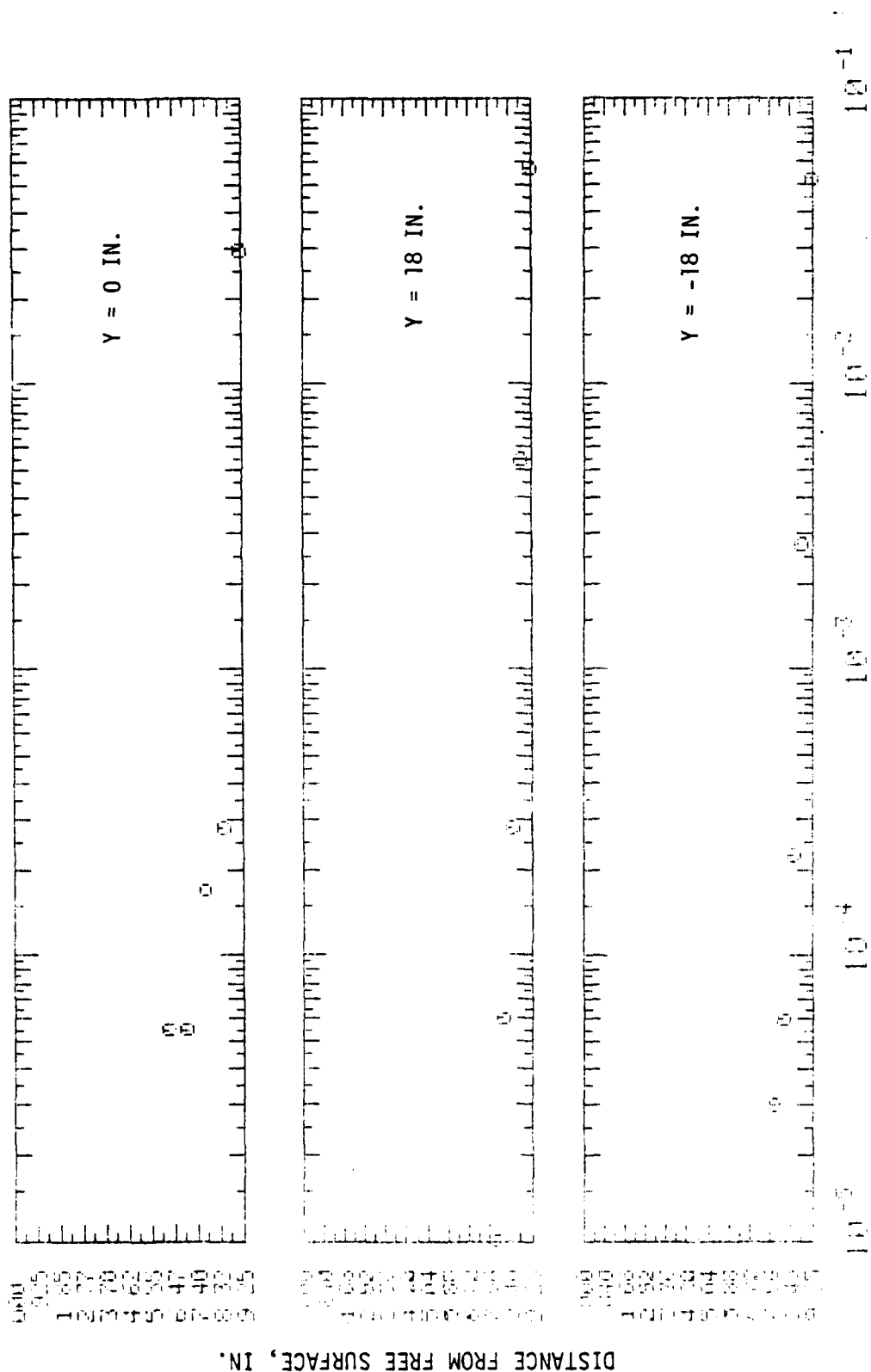
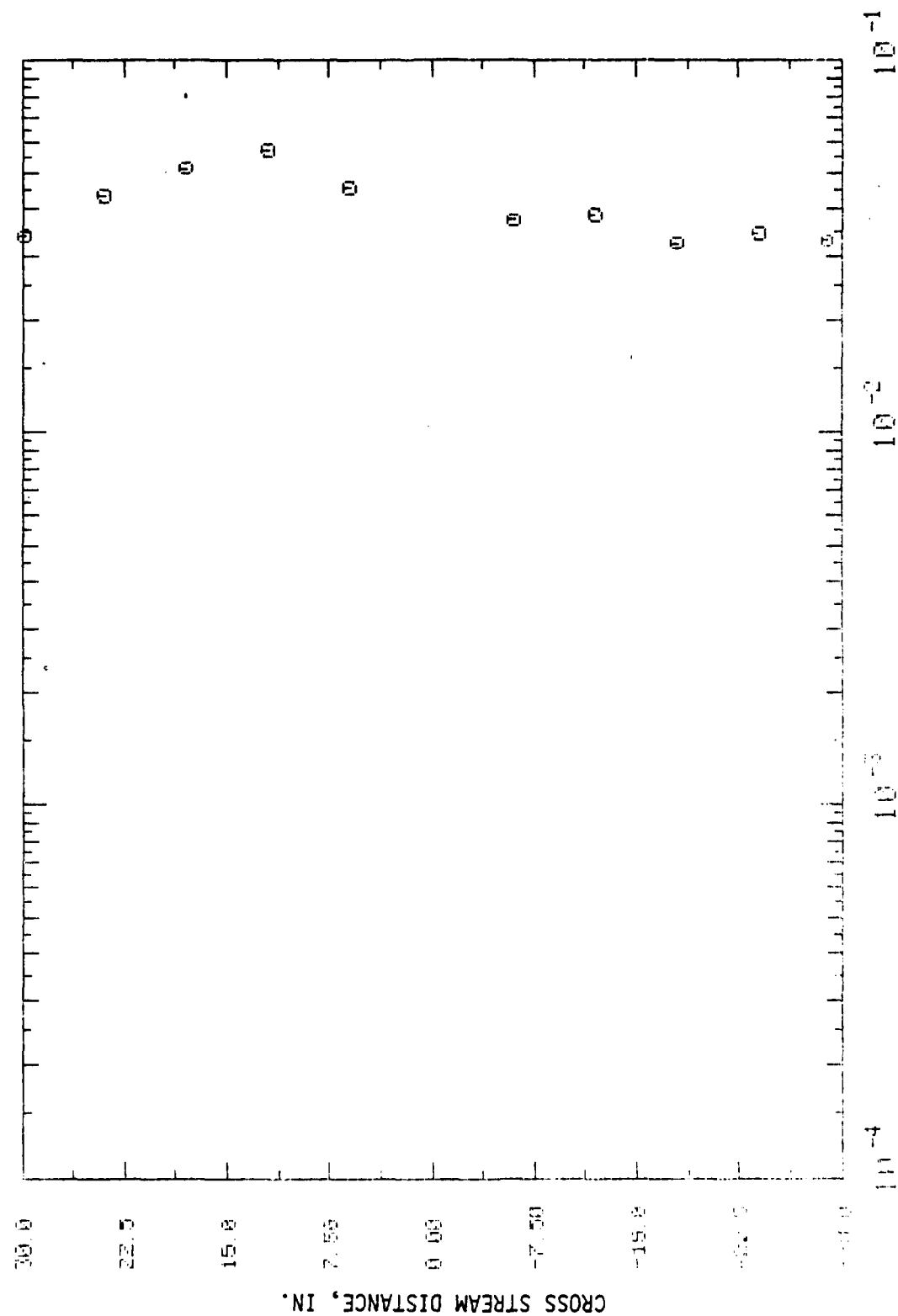


FIGURE Q-2. RUN I.2-20 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 9.25 IN.

FIGURE Q-3. RUN 1. 2-20 CROSS STREAM CONCENTRATION PROFILE

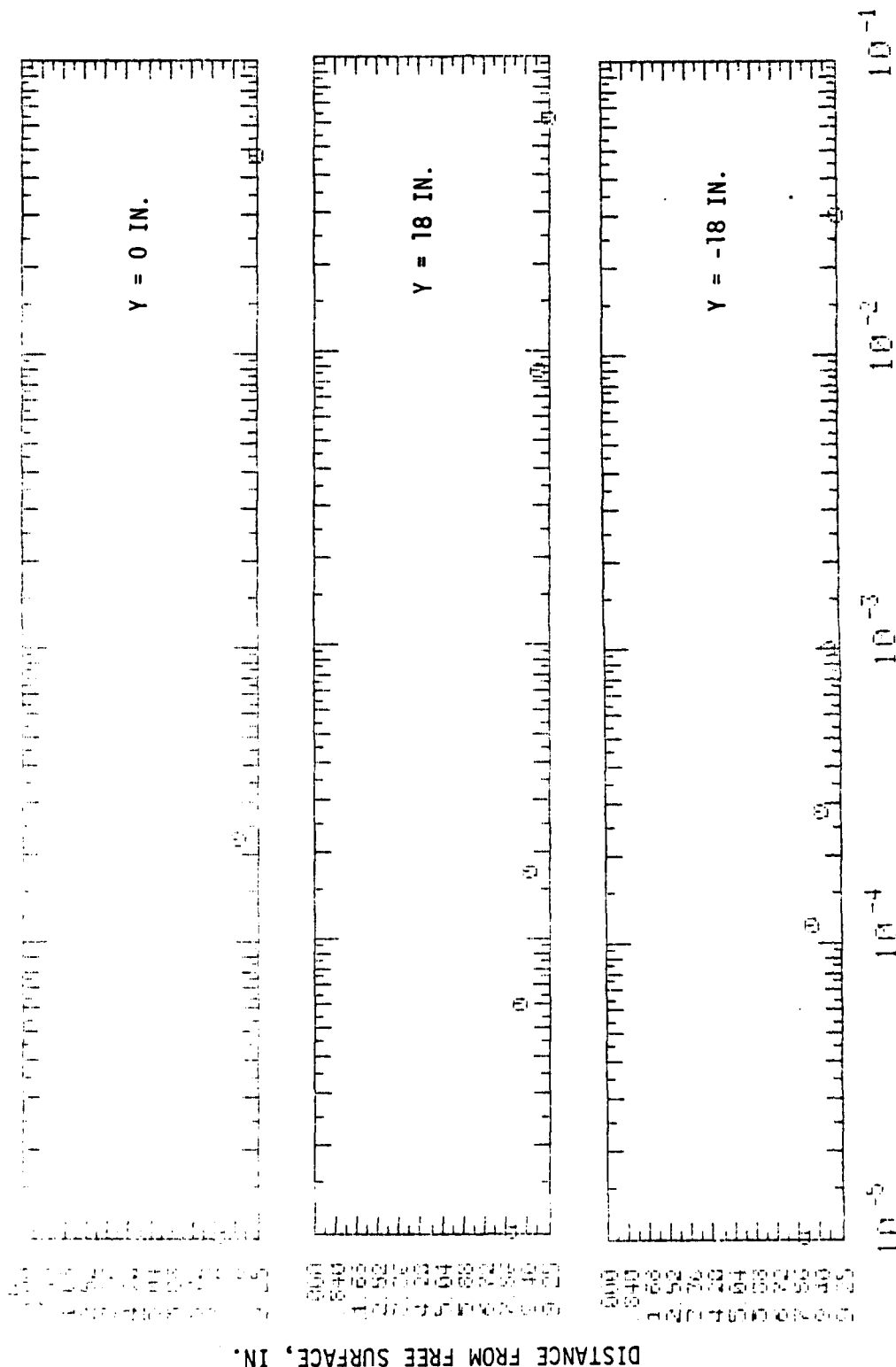


FIGURE Q-4. RUN I. 2-20 VERTICAL CONCENTRATION PROFILES

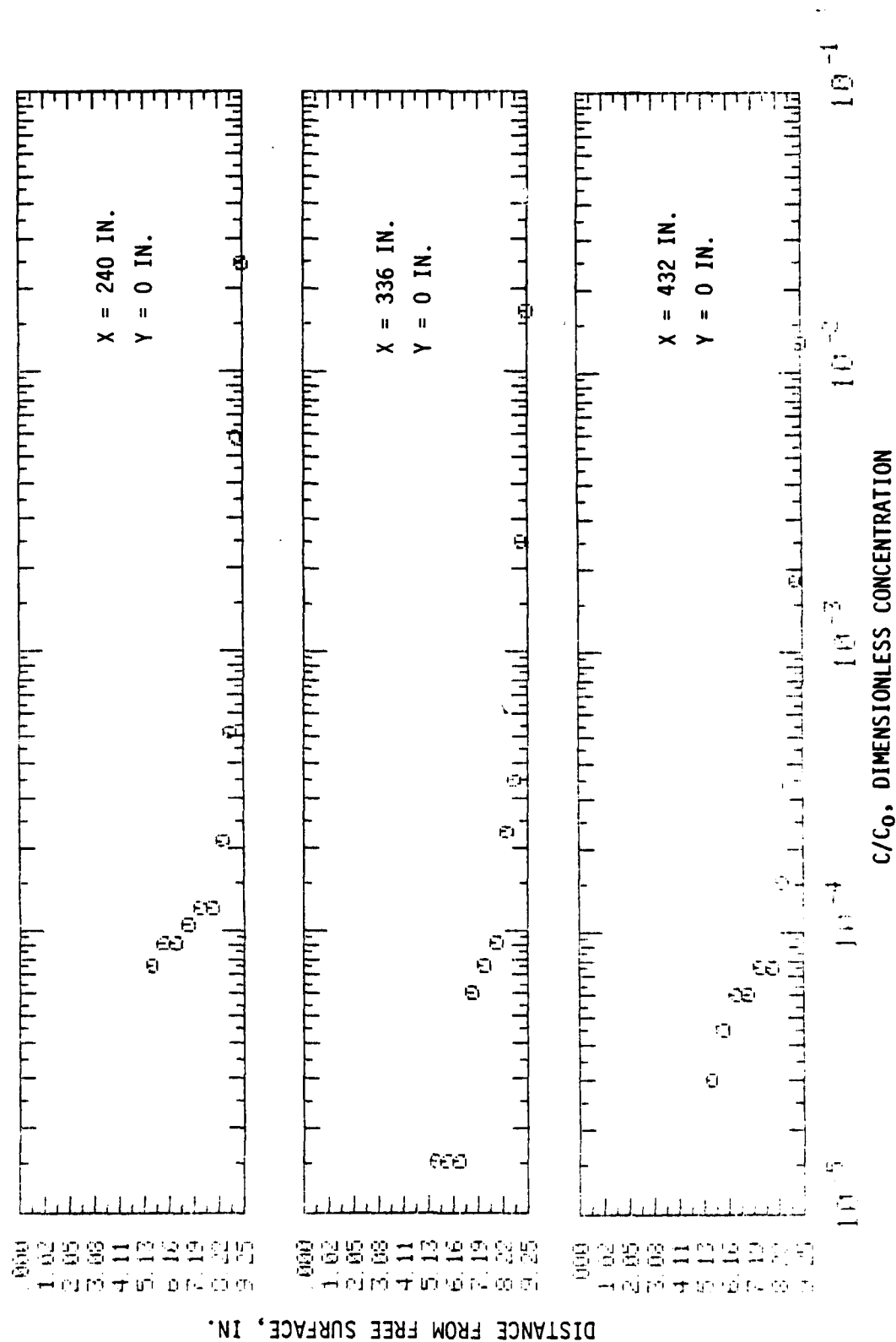


FIGURE Q-5. RUN I.2-20 VERTICAL CONCENTRATION PROFILES

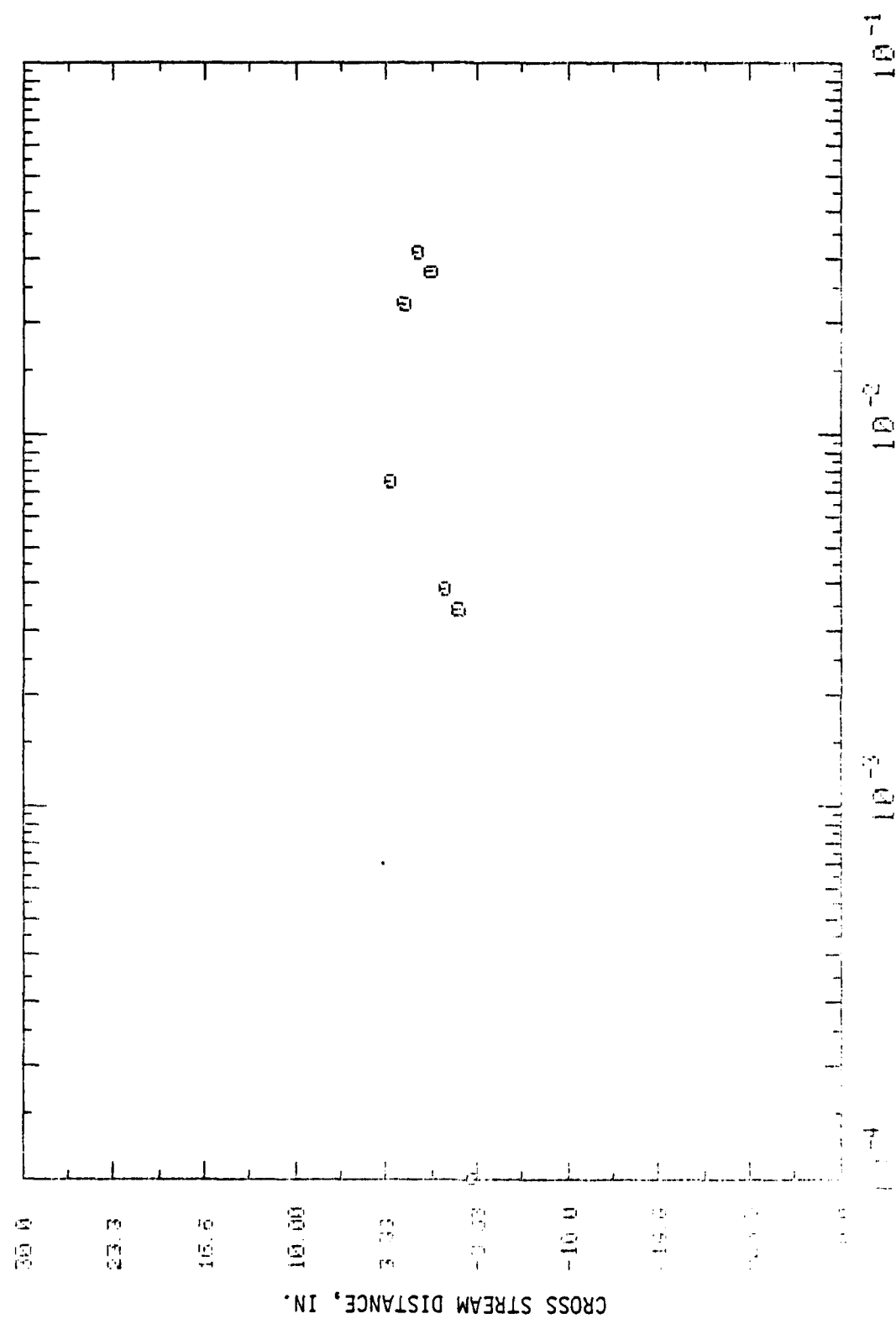
APPENDIX R

CONCENTRATION PROFILES FOR
RUN I.2-26 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 1.0$$

$$J = 16.0$$

$$Fr = \text{Infinite}$$



C/C₀ DIMENSIONLESS CONCENTRATION

X = 48 IN., Z = 3.75 IN.

FIGURE R-1. RUN I. 2-26 CROSS STREAM CONCENTRATION PROFILE

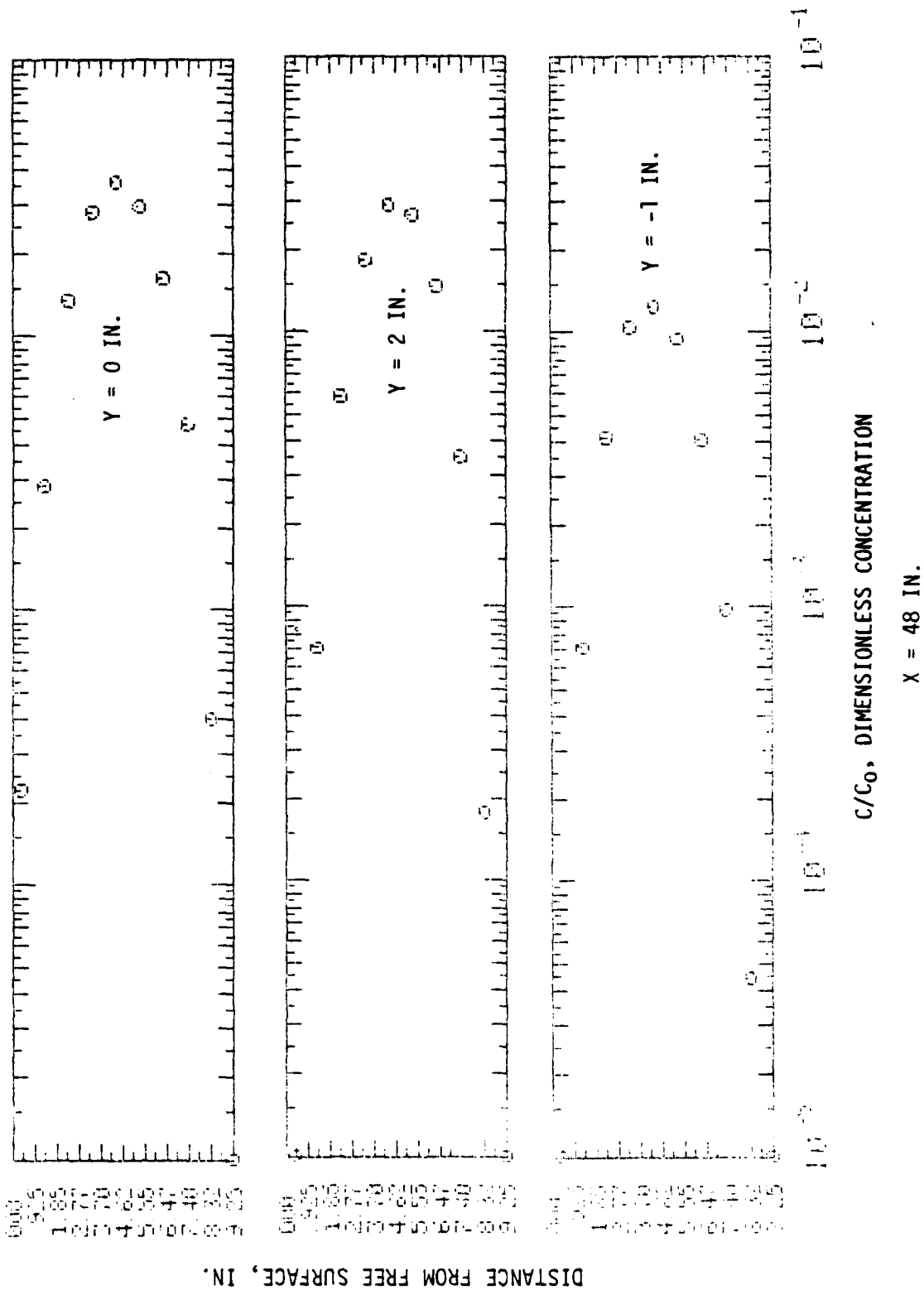
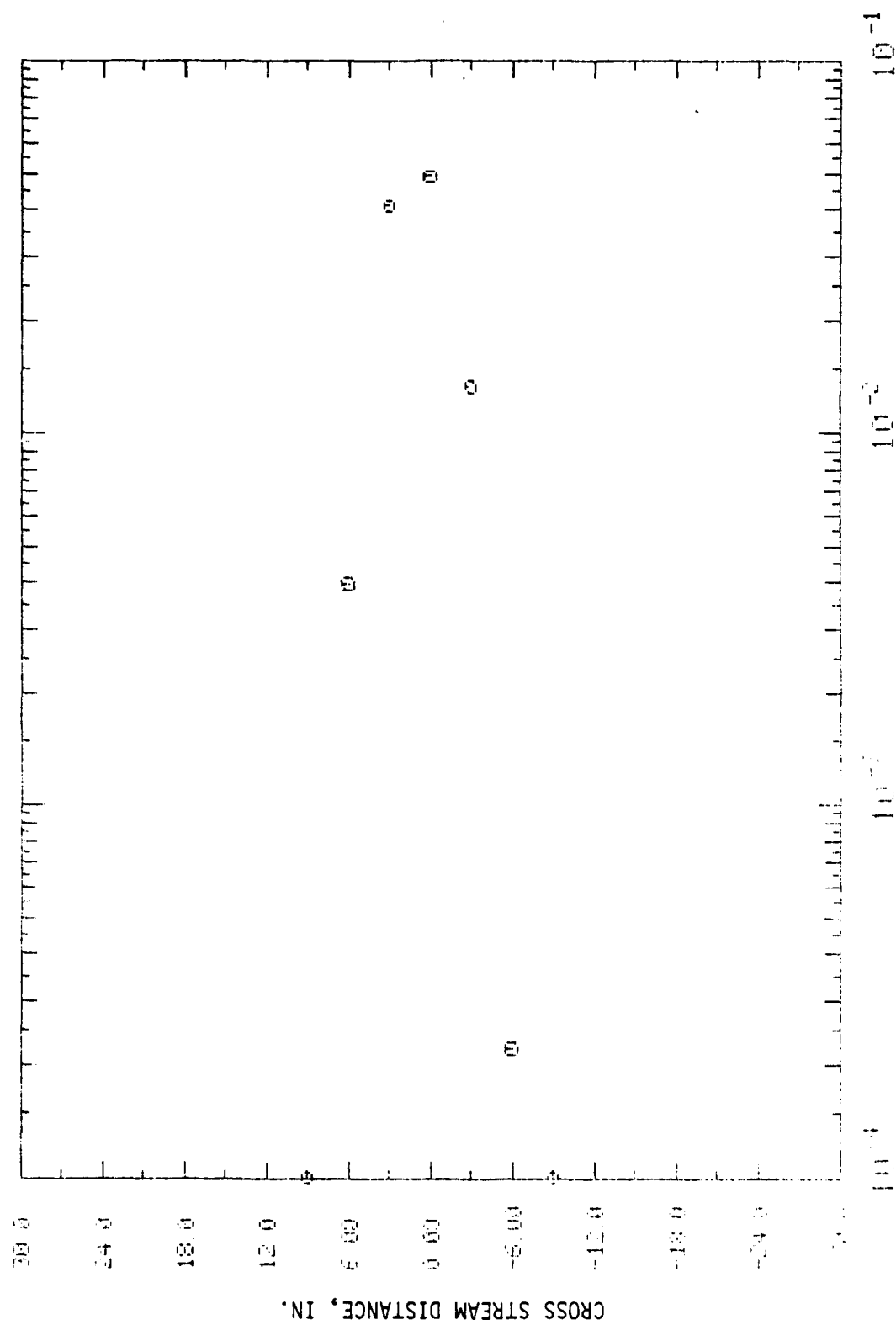


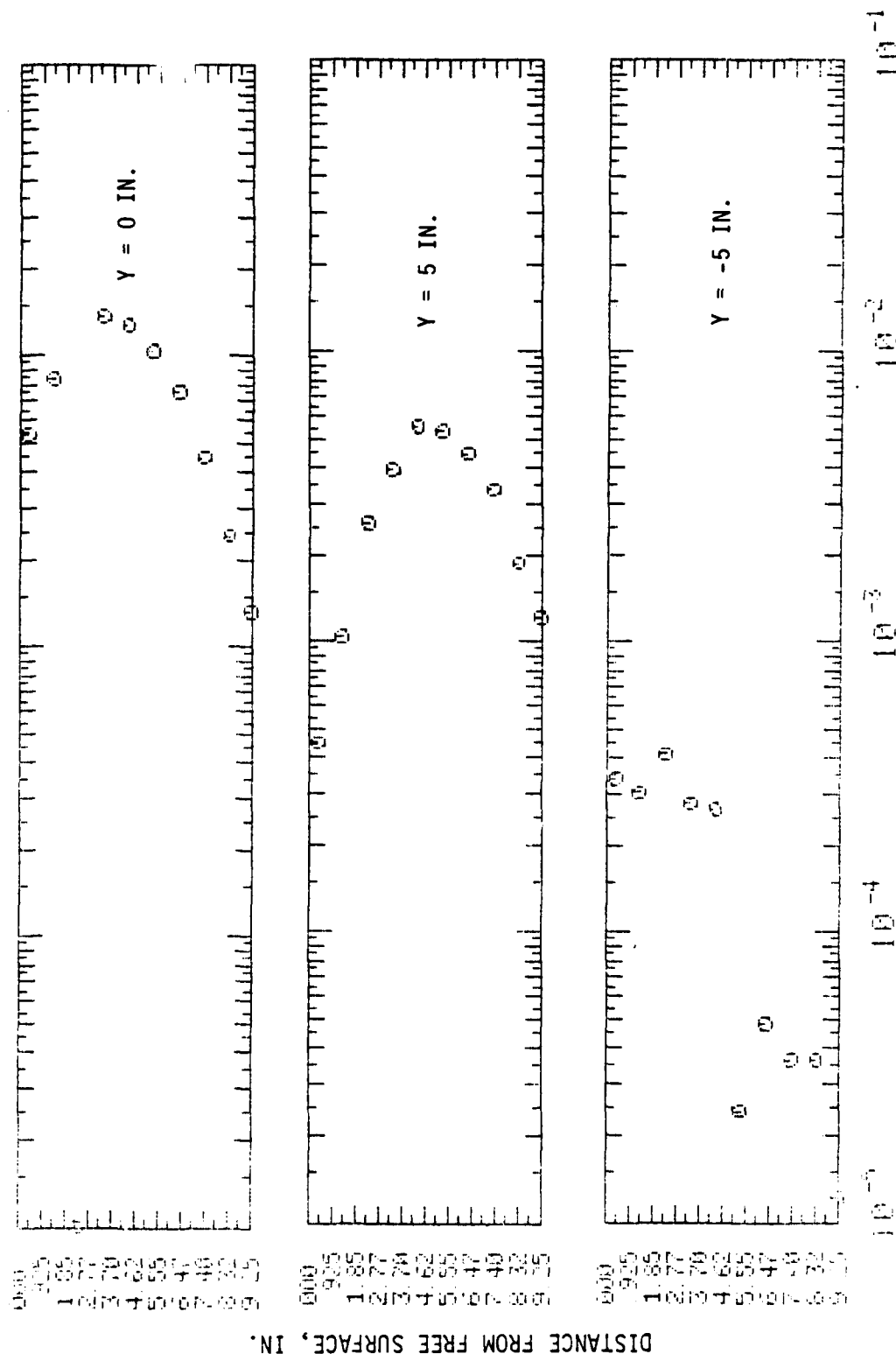
FIGURE R-2. RUN I. 2-26 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 3.75 IN.

FIGURE R-3. RUN I.2-26 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 120$ IN.

FIGURE R-4. RUN I. 2-26 VERTICAL CONCENTRATION PROFILES

APPENDIX S

CONCENTRATION PROFILES FOR
RUN I.2-27 AT X = 120 IN.,
240 IN., 432 IN.

$$\rho_c/\rho = 1.05$$

$$J = 7.5$$

$$Fr = 0.51$$

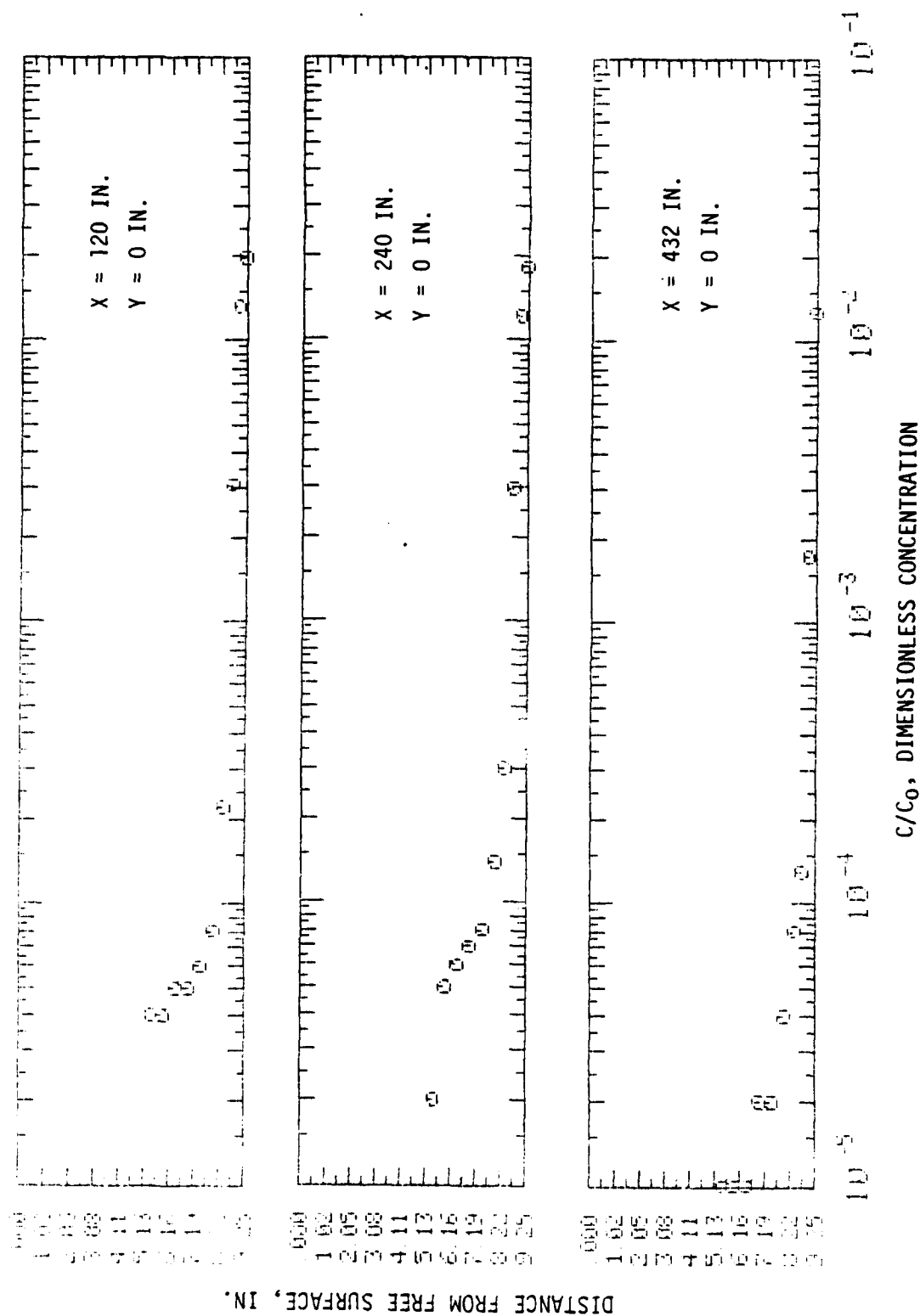


FIGURE S-1. RUN I.2-27 VERTICAL CONCENTRATION PROFILES

